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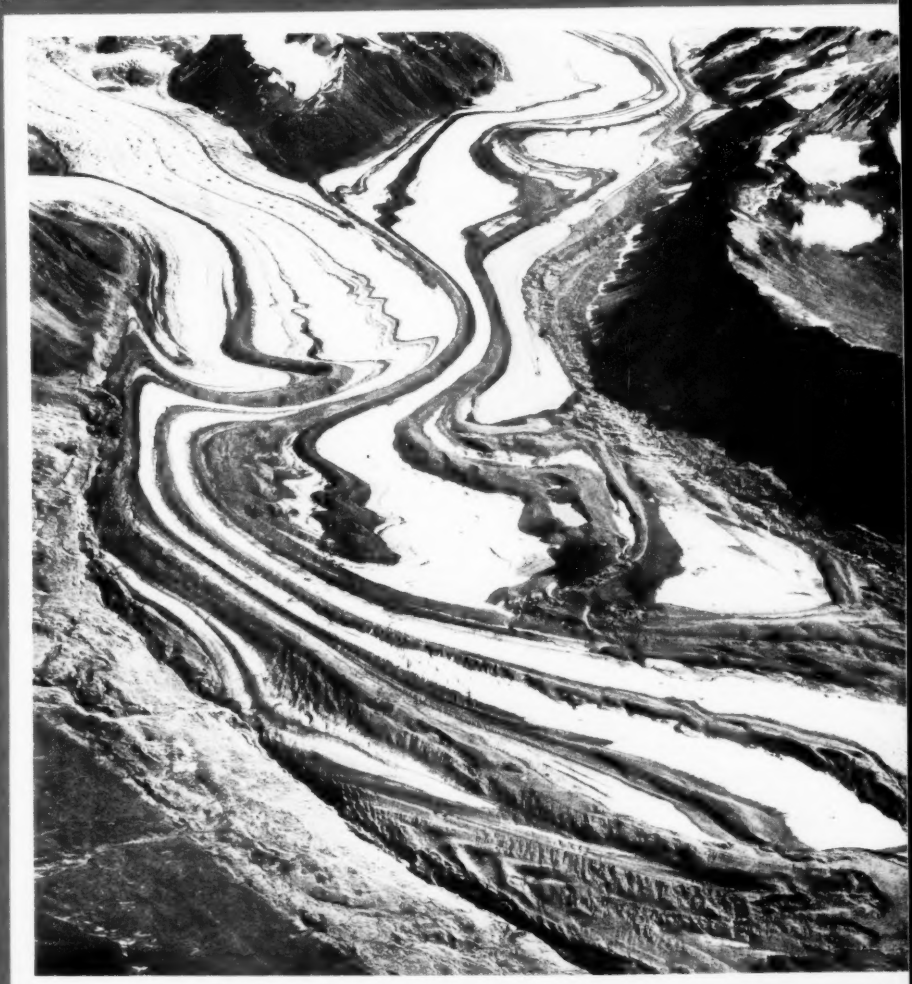

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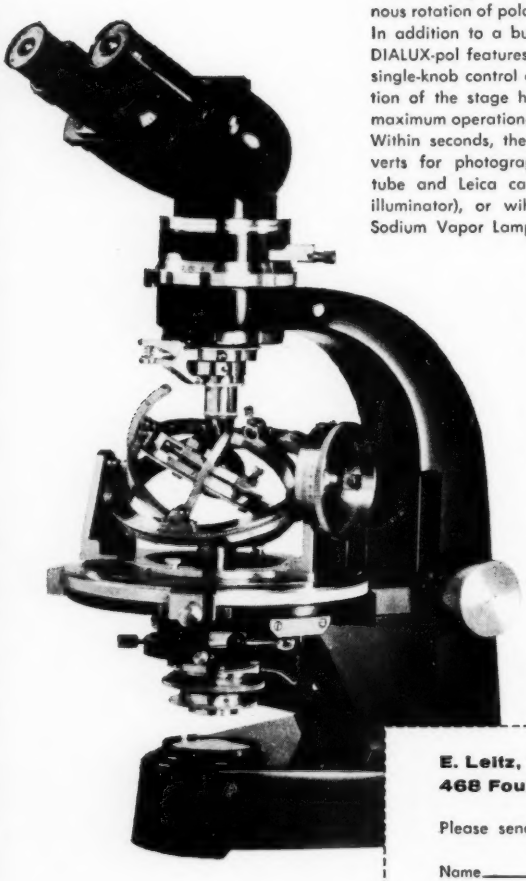

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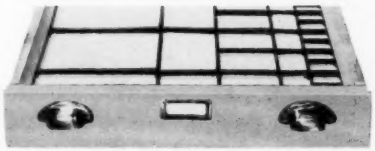

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Calendar

Cooperation of Society Secretaries in supplying meeting notices for GEOTIMES calendar is requested.

April 9-11, 1961—SEGp: Ann. Midwestern Meeting, Oklahoma City.

April 10-May 21, 1961—SEVENTH COMMONWEALTH MINING & METALL. CONG., Johannesburg, So. Africa.

April 13-15, 1961—AIME: Pacific Northwest Metals & Minerals Conf., Davenport Hotel, Spokane, Wash.

*April 13-15, 1961—GSA: SE SECTION Ann. meeting, Andrew Johnson Hotel, Knoxville, Tenn. Sponsored by Univ. of Tenn. and Tenn. Division of Geology. Papers—2 days, field trips —1 day. Write: Harry J. Klepser, Dept. of Geology, Univ. of Tenn., Knoxville.

April 17-19—CIM: Annual General Meeting, Chateau Frontenac, Quebec City, Quebec.

*April 18-19, 1961—MUSKEG RESEARCH CONF., 7th Ann. Meeting, McMaster Univ., Hamilton, Ont. Field trip planned. Write: I. C. McFarlane, c/o Div. of Bldg. Research, Nat. Research Council, Ottawa 2, Canada.

April 18-21, 1961—AGU: Ann. meeting, Nat. Acad. Sci., Washington, D. C.

April 20-21, 1961—AIME: Soc. of Petrol. Eng., East Texas-Lou.-Ark., gas technology symposium, Tyler, Texas.

April 20-21, 1961—AASG: Ann. meeting, Moscow, Idaho.

April 20-22, 1961—OHIO ACAD. OF SCIENCE, 70th Ann. Meeting, Univ. of Cincinnati.

April 23-27—ACerS: 63rd Annual Meeting, Royal York Hotel, Toronto, Ontario.

April 24-25, 1961—AIME: Nevada Sect., South-West Mineral Industry Conf., in conjunction with Industrial Metals, Stardust Hotel, Las Vegas, Nev. Write: L. J. Hartzell, P. O. Box 2008, Henderson, Nevada.

*April 24-27, 1961—AAPG-SEPM: 46th Ann. Meeting. Jointly with Rocky Mountain Sect., A.A.P.G., Hilton Hotel, Denver, Colo. Field trips before and after meetings to study all phases of Colorado geology. Write: Laurence Brundall, 305 E & C Bldg., Denver 2.

April 27-29, 1961—6th ANN. INST. OF LAKE SUPERIOR GEOLOGY, Port Arthur, Ont., Canada. Write: E. R. Mead, 213 Park Street, Port Arthur.

April 28, 1961—W. VA. ACAD. OF SCIENCE, Geol. and Mining Sect., Bethany College, Bethany, W. Va.

May 4-5, 1961—AIME: Soc. of Petrol. Eng., oil recovery conf., Midland, Texas.

*May 4-6, 1961—NEW MEXICO GEOL. SOC. Spring Tech. Meeting, Roswell, N. Mex. Symposium on San Andres limestone; field trip to Last Chance Canyon, Guadalupe Mtns. Write: Sam Thompson, Box 1287, Roswell.

*May 11-13, 1961—GSA: Rocky Mountain Sect., meeting at Laramie, Wyo., with 1-day field trip to study Precambrian and sedimentary rocks and geomorphology in the Laramie Basin. Write: W. R. Keefer, Box 3007, Univ. Sta., Laramie.

*May 12-14, 1961—AIME: Central New Mexico Sect., Sixth Ann. Uranium Symposium, Grants, N.M. Field trip to neighboring mines and mills.

May 17-19, 1961—SOC. OF PROFESSIONAL WELL LOG ANALYSTS, 2nd Ann. Meeting and Logging Symposium, Sheraton-Dallas Hotel, Dallas.

May 25-26—AIME: Joint Meeting Rocky Mountain Petroleum Sects., Salt Lake City, Utah.

June 26-29, 1961—CANADIAN SOIL SCIENCE SOC., Ann. Meeting, Regina, Sask., Canada.

June-July, 1961—WORLD METEOROLOGICAL ORGANIZATION, Regional Assoc. III (South America), Session, 3rd, Rio de Janeiro, Brazil. Campagne Rigot, Av. de la Paix, Geneva, Switzerland.

July 17-22—INTERNAT. CONF. ON SOIL MECHANICS & FOUNDATION ENGINEERING, 5th, Paris, France. M. Buisson, Gen. Sec'y., Assoc. Francaise de Mech. des Sols et des Fondations, 31, rue Henri Rochefort, Paris 17e, France.

July 30-Aug. 4, 1961—AMER. CRYSTALLOGRAPHIC ASSOC., Boulder, Colo.

Aug. 21-31, 1961—U.N. CONF. ON NEW SOURCES OF ENERGY, (Solar Energy, Wind Power and Geothermic Energy), Rome. Write: U.N., New York.

Aug. 21-Sept. 6—PACIFIC SCIENCE CONGRESS, 10th, Honolulu, Hawaii. Pacific Science Assoc. Secretary General, 10th Pacif. Sci. Cong., Bishop Museum, Honolulu 7, Hawaii.

Aug. 21-Sept. 6—SPECIAL COMMITTEE ON OCEANIC RESEARCH, 5th Meeting, Honolulu. Dr. Günther Böhnecke, Secy., Bernhard-Nochstr. 78, Hamburg 4, Germany.

Aug. 27-Sept. 21, 1961—INTERNAT. ASSOC. ON QUATERNARY RESEARCH, 6th Internat. Congress, Warsaw, Poland.

Summer—INTERNAT. COUNCIL OF SCIENTIFIC UNIONS, 9th General Assembly, London, Eng. National Academy of Sciences-National Research Council, Washington 25, D. C.

Sept. 3-8, 1961—AMER. CHEM. SOC., 140th meeting, Chicago, Ill.

Sept. 18-23—III INTERNAT. CONGRESS OF SPELEOLOGY, Vienna, with excursions before and after the meetings. Write: Generalsekretariat des 3. Internationalen Kongresses für Speläologie, Verband österreichischer Höhlenforscher, Wien II, Obere Donaustrasse 99/7/3.

Oct. 8-11, 1961—AIME: Soc. of Petr. Engrs., Fall meeting, Dallas, Texas.

*Oct. 14-18, 1961—NATIONAL CLAY CONF., Univ. of Texas, Austin. Field trip Oct. 14 to bentonite localities of Texas Gulf Coast and vermiculite field trip Oct. 15. Write: E. Joseph Weiss re program or papers and Stephen E. Clabaugh re field trips, both at Univ. of Texas.

Oct. 18-20, 1961—OPTICAL SOC. OF AMER., Ann. Meeting, Los Angeles, Calif.

Oct. 18-21, 1961—AAPG: Mid-Cont. Regional meeting, Amarillo, Texas.

Oct. 25-27, 1961—GULF COAST ASSOC. OF GEOL. SOC'S., meeting, San Antonio, Tex.

*Nov. 1-3, 1961—SOUTHWESTERN FED. OF GEOL. SOC'S., Ann. Meeting. El Paso, Tex. Trip into northern Chihuahua, Mex. to study geol. of the area. Write: Texas Western Coll., Geol. Dept., El Paso.

Nov. 2-3, 1961—AIME: Soc. of Petr. Engrs., 32nd Ann. California regional meeting, Los Angeles, Calif.

*Nov. 2-4. 1961—GSA: Ann. Meeting, Cincinnati, Ohio. Nine trips through area around Cincinnati to study Paleozoic stratig. and struct.; Write: Ralph J. Bernhagen, Ohio Geol. Surv., Ohio State Univ., Columbus 10. re trips. Guidebooks.

Nov. 5-9. 1961—SEGp: 31st Ann. Internat. Meeting, Denver, Colo.

Nov. 13-15, 1961—A.P.I.: Ann. Meeting, Chicago.

Dec. 26-31, 1961—AAAS: Ann. Meeting, Denver, Colorado.

*December—TEXAS ACAD. OF SCI., Ann. Meeting. Trip through Gulf Coastal area to study recent sedimentation. Write: W. R. Muehlberger, Dept. Geol., Univ. Texas, Austin 12.

Field Trip Calendar next page

1961 SCHEDULE OF FIELD TRIPS

For additional field trips held in conjunction with meetings, see those items marked with an asterisk under meeting calendar.

April 7-8—GEOL. SOC. OF KENTUCKY, Ann. Spring Field Conf., Middlesboro, Ky., to study "Geologic features of Cumberland Gap area, Ky., Tenn., and Va." Write: T. J. Crawford, Ky. Geol. Surv., Univ. of Ky., Lexington.

April 14-15—TULSA GEOL. SOC. & FORT SMITH GEOL. SOC., joint field trip to study Miss., Penn. and petrol. geol. of Arkoma Basin. Hdqtrs: Goldman Hotel, 1215 Garrison Ave., Fort Smith. Write: Dorsey Ryan, 1320 North B St., Fort Smith, Ark.

April 15—ILLINOIS STATE GEOL. SURV., trip to Mississippian strata and glaciation evidences of the Sparta region, Randolph County, Ill.

April 19-23—SIGMA GAMMA EPSILON, Kansas State Univ., trip E. Kans. to Illinois and return to study geology along routing. Write: Arthur Booth, Dept. Geol., KSU, Manhattan, Kans. Mimeo Guidebook.

May 5-7—GEOLOGIC FIELD CONF., 10th Indiana on Stratigraphy of the Silurian rocks of Northern Indiana, Indiana Geological Survey joint with Dept. of Geology, Indiana University. Hdqtrs. Spencer Hotel, Marion, Ind. Write: M. E. Biggs, Geol. Survey, Bloomington, Ind.

May 5-7—SOUTHWESTERN ASSOC. OF STUDENT SOC'S. 2nd ann. field trip to "Arbuckle Mountains and Criner Hills of Oklahoma." Chairman: Prof. J. Loyd Watkins, % Midwestern University, Wichita Falls, Tex. Guidebook.

May 6—ILLINOIS STATE GEOL. SURV., trip to study Mississippian formations and to collect geodes and fossils in the Hamilton region, Hancock County, Ill.

May 12-13—SEPM-SAN JOAQUIN GEOL. SOC., trip to San Joaquin Valley in so. part of Kern Co. to study Tertiary rocks of so. part of Valley. Write: Richard Pierce, Box 147, Bakersfield, Calif. Guidebook.

May 13—SEPM-GULF COAST SECT., trip to Houston, Cherokee and Nacogdoches Co's. to study type localities of Cook Mtn., Crockett, Weches and Reklaw Eocene fms. Write: Richard P. Zinguia, Box 2180, Houston 1. Guidebook.

May 20—ILLINOIS STATE GEOL. SURV., trip to Mazon Creek and Braidwood plant fossil collecting areas, quarries and outcrops of Morris area, Grundy County, Ill.

May 20-21—EASTERN FRIENDS OF PLEISTOCENE, trip to SW Maine to study Late Pleistocene and marine stratigraphy. Write: Arthur L. Bloom, Cornell Univ., Ithaca, N.Y.

May 27-28—GEOL. SOC. OF SACRAMENTO, trip to Sacramento Valley on E. side to study Marysville Butte and Feather R. Canyon, etc. Write: Lowell Garrison, Box 4195, Sacramento 21. Guidebook.

(Continued on page 39)

FIELD TRIP CALENDAR

Most of the information regarding field trips in this calendar appears through the courtesy and cooperation of the AAPG Field Trip Committee. Corrections, additions and new trip notices should be sent to George H. Fentress, Chairman, AAPG Field Trip Committee, P. O. Box 2585, Denver 1, Colo., with a carbon copy to GeoTimes Calendar, American Geological Institute, 2101 Constitution Ave., N.W., Washington 25, D. C.

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Robert C. Stephenson, EDITOR

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VOL. V, No. 7 April 1961

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New Frontier in Geology

"No new starts" is the newest synonym for lethargy—at least from one political point of view—that is being bandied about as one of the catch phrases associated with the changing of the political guard and the shaping of the New Frontier.

Among a growing corps of well-trained younger geological scientists there is an increasing restiveness and a feeling that there is need for some new frontierism and less no-new-startism in geology. For while the body of geologic knowledge is growing constantly, the advance is about as ragged as that of a company of Civil War foot soldiers charging in the face of withering artillery fire. The biggest advances are on the fringes of geology, in geochemistry for example. Here scientists of other disciplines are moving with enthusiasm on geological problems, anxious to apply new basic scientific concepts and new scientific methods to challenging problems of geological research.

Much of geology and many geologists are bogged down in long established patterns of no-new-starts. There appears to be a prevalent attitude of apathy toward the intriguing possibility of a profession-wide effort to delineate the new frontiers of geologic research, an effort which could serve as the basis for mounting a broad, ambitious, vigorous, forward-looking program by geologists to advance the state of geologic knowledge.

Why the foot-dragging? Is it in part the long-standing conservatism of geologists? . . . are our aims more commercial than scientific? . . . are too many of the old and middle guard so lacking in awareness of modern scientific concepts to visualize the challenges? . . . are we too entrenched to change? . . . or are we afraid of the 'long view'?

The steadily improving geological curricula of many schools is producing a growing number of geological scientists who are well trained in the basic sciences. These members of the "new guard" are ready for new frontiers in geology. Members of the "old and middle" guards who cannot adjust to the modern pace of science must stand aside if geology is to advance apace with science in general. On the other hand, by recognizing and adjusting to the impact of modern science on geology they can function as a balance wheel rather than as a brake in getting geology rolling toward the new frontier.

OUR COVER

Deformed Moraines in lower reach of the Susitna Glacier in the Alaska Range. Air photo by Bradford Washburn. (see Glaciers, p. 38)

The **AMERICAN GEOLOGICAL INSTITUTE** is a non-profit professional service organization established and managed by the scientific societies in the fields of geology and geophysics in cooperation with the National Academy of Sciences-National Research Council. It is the instrument of the profession serving and advancing the welfare of the geoscientist in matters relating to education, professional responsibilities and government relations. It is an active member of the Scientific Manpower Commission. It also functions in the stimulation of public education and awareness of the earth sciences, through career literature, the scouting program and other channels of communication.

GEOTIMES is the news magazine of the geological sciences. It reports on current events in the earth sciences, public education and public relations efforts throughout the profession, as well as appropriate legislative and governmental issues. It announces scholarships, fellowships, publications and new developments. It provides a forum for discussion of timely professional problems, and affords a common bond between the many specialized groups within the earth sciences.

From Geologic Data . . .
. . . to Aquifer Analog Models

by R. W. STALLMAN [1]

Analog-computer developments of the U. S. Geological Survey were described in a press release of September 18, 1960. The following is a more detailed account of this equipment and explains the role of analog computers in ground-water studies. Electric analogs have proved to be a versatile, simple, and low-cost means for computing solutions to areal problems of nonsteady liquid flow through porous media. The Survey's Ground Water Branch has put an analog computer unit in operation to utilize field data more effectively in forecasting ground-water conditions in selected areas.

The U.S. Geological Survey is charged with the responsibility of evaluating the Nation's ground-water resources.To do this job, the Survey's Ground Water Branch is currently staffed with about 300 geologists and 100 engineers, plus a relatively small number of physicists, chemists, and mathematicians. The geologist applies his training and philosophy to describe the water-bearing characteristics of the system of rocks in general or qualitative terms, whereas the engineer is chiefly concerned with quantitative measurement of the hydraulic characteristics and the response of the underground system to water development. Most of the geologists and engineers work together in teams as hydrologists, effectively combining their talents to describe the ground-water resources of selected areas. Those not working entirely in field teams support the field studies by means of research studies.

The work of the field teams constitutes the major part of the program of investigation, which is designed to supply information on ground-water occurrence to water users. Both terms, "information" and "water users", cover wide spans. "Information" includes everything from a measurement of a single ground-water level to a comprehensive report on the role of ground water in basinwide water developments. "Water user" loosely identifies aggregations, ranging in size from the individual upward, of people specifically interested in the development or use of ground water. Because there is such a wide range of need for information demanded by an equally wide field of water users, the field projects are highly nonuniform as to areal coverage, type and density of data collection, and tenor of reports summarizing field observations. Areal limits are selected and investigational emphasis is decided jointly by Federal, State, and local government representatives to assure that each project undertaken serves all interests adequately. The water user's need for information is the dominant factor in assigning priority to project areas and in determining the technological depth of investigations.

AN ANALYTICAL PROBLEM

Questions pertaining to the productive life of a given aquifer system, interference effects between separately operated pumping systems, and interrelations between surface and ground water frequently arise where large-scale water development is undertaken. These are but a few examples of the many questions that arise from the time water planning is begun, onward through development to such a stage that priority of use becomes a subject of argument. Questions of this type often require that the aquifer system be defined and analyzed quantitatively in such a way that pumping is related to water-level changes, space, and time.

Methodology available for analyzing problems of this nature has been woefully inadequate. The engineering approach to ground-water hydraulics has been founded almost entirely on mathematical solutions of the differential equations of ground-water flow, developed mainly from the calculus.

Analytical equations developed in this way relate the aquifer's hydraulic characteristics to discharge, time, and space. They can be applied for calculating the

[1] R. W. STALLMAN, Ground Water Branch, Research Section, U.S. Geological Survey, Denver Federal Center.

aquifer's hydraulic characteristics or for calculating aquifer response, provided the hydrologic conditions of the aquifer system are analogous to the conditions prescribed in deriving the equation. Usually these prescribed conditions include homogeneity of the aquifer, highly idealized interrelations with surface-water occurrence, a restriction to only one- or two-dimensional flow, a simple geometrical shape of the aquifer boundaries, and simple functional relations between head and discharge along the boundaries of the aquifer system.

The field geologist and engineer find that aquifer systems cannot be defined with sufficient accuracy or detail by these simple or idealized relations. Presumably more complicated analytical equations could be derived that would encompass the known complicating conditions. However, because each aquifer system is uniquely complicated, each comprehensive areal flow analysis would require the development of an extensive set of equations, and, it is doubtful that such an approach would be technically or economically feasible.

The Geological Survey several years ago recognized the serious limitations on comprehensive areal flow studies created by the inadequacy of analytical techniques, and gave much thought to corrective measures. Chiefly, the problem appeared to be one of finding a means for calculating flow distribution in nonhomogeneous systems having highly irregular shapes and a wide variety of head and discharge controls. Studies of several methods of analysis generally applied in other branches of science were made to find which might be of most general utility, and yet would remain within relatively stringent budgetary limitations. These early studies indicated that electric analogs, composed of models and analyzers, would meet most problem requirements from both technical and economic viewpoints. Early work on the selection and development of analog equipment was headed by H. E. Skibitzke, mathematician, U.S. Geological Survey, Phoenix, Ariz. He and his associates brought the Survey's analog work to its present state of usefulness in areal ground-water studies.

Analog Design and Cost

Models for simulating the aquifer system are designed by utilizing the correspondence between the basic laws and continuity relationships of laminar liquid and electrical flow. The analogy and appropriate physical criteria may be used to show that the linear dimensions of an electrical model are directly proportional to the corresponding linear dimensions of the aquifer system:

Figure 1. Migration of mineral constituents in ground water being outlined with the aid of an analog plotter.

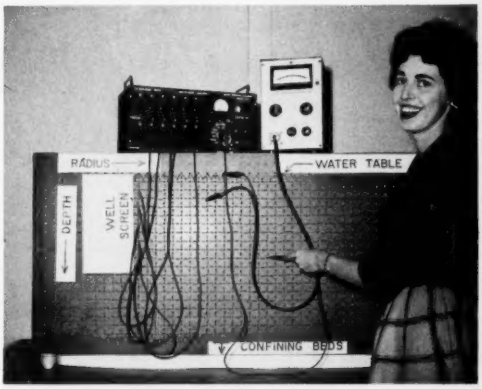

Figure 2. Analysis of three-dimensional pumping test data in an unconfined aquifer, tapped by a partially penetrating pumped well.

the model resistivity is inversely proportional to the hydraulic conductivity of the aquifer, and the storage characteristic of the aquifer is proportional to the electrical capacitance of the model. Thus, the electrical model of an aquifer flow system is simply an array of electrical components selected and placed in a manner such that the electrical network functions as a scaled version of the aquifer system. The selection of model components is a relatively simple problem in arithmetic.

The interrelations among the variables of flow in the model and the aquifer prototype may be applied in several ways, depending on the types of electrical components to be used in the model. The selection of model design, in turn, is governed by the type of aquifer flow system to be investigated. For ground-water studies, these systems range in complexity from the one-dimensional steady-flow condition in a homogeneous aquifer to the three-dimen-

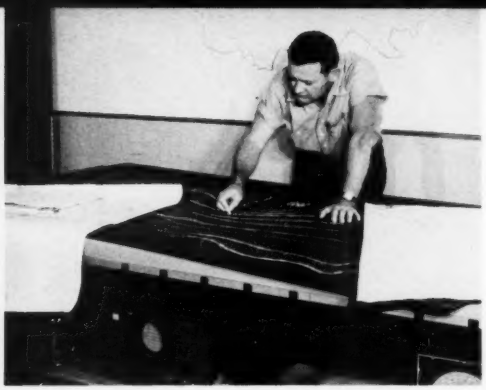

Figure 3. Transferring aquifer hydraulic coefficients from field data to model assembly form. Resistance and capacity values over the model area are determined directly from the coefficients indicated by contouring. (Photo courtesy USGS, Phoenix, Arizona, analog unit)

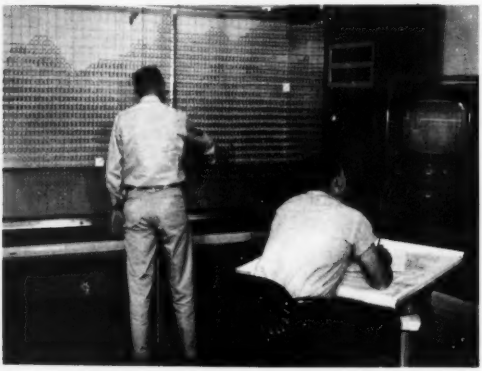

Figure 4. Completed resistor-capacitor model used for studying response of aquifer system to pumping. (Photo courtesy USGS, Phoenix, Arizona, analog unit)

sional nonsteady-flow condition in a nonhomogeneous aquifer.

The cost of analyzer control for simulating hydrologic boundary conditions electrically at one boundary point is closely dependent on the complexity of the hydrologic variable. For example, a constant head, represented by an unregulated voltage held only approximately constant with time, may be applied at one model point for only a dollar or two. If regulated voltage is supplied at one model point and held constant so that variations are less than the sensitivity of the measuring instruments normally used, the cost may be $10 to $20 per point. Control of voltage or current to simulate specific nonsteady head or discharge relations at one model point may cost more than $300. These unit costs refer only to model controls and do not include the cost of other analyzer equipment required for observing and recording the flow conditions in the model.

Analog equipment designed to study nonsteady flow through nonhomogeneous aquifers can be used for all problems of lesser complexity, thus wrapping up the analog methodology in one neat package. But early financial limitations restricted the amount of control equipment to a bare minimum, and therefore the initial analog equipment was restricted to the solution of relatively elementary flow problems. Also, setting up and operating a nonsteady analog device for solving steady-flow problems incurs unnecessary expense.

Limitations imposed by operational factors, available funds, and management scheduling prompted developments along the following three principal lines: (1) Designing and testing a small low-cost, durable analog plotter unit for field-office use in studying steady-state flow problems. (2) Designing and testing a regulated electrical flow system, using a network of variable resistors, for laboratory model studies of steady flow through nonhomogeneous aquifers—a flow condition found predominantly in the humid areas of the United States. (3) Designing and testing electrical systems for modeling nonsteady flow through nonhomogeneous aquifers—a flow condition related, for example, to the mining of water in some irrigated areas in the West.

Equipment Developments

The analog plotter unit, or "black box" as it has been affectionately labeled, was designed mainly for use with electrically conductive paper. It contains several voltage-current outlets, a combination galvanometer-current meter circuit, and a voltage divider. Current flow and voltage at each outlet may be monitored individually without the need for applying external circuitry. Figure 1 shows one of the plotter units hooked up to an areal-flow model. Approximately 30 of these units are now in use in field offices of the Survey's Ground Water Branch throughout the country.

Figure 2 shows another of the black boxes and a high-sensitivity meter hooked up to a resistance model designed to analyze water-table pumping-test data.

Figure 3 shows one step in model construction. Contours of the aquifer's hydraulic conductivity are transferred from field information to a sheet of pegboard. The pegboard is used as a form for assembling model resistors. The individual resistance values are selected as a linear function of the hydraulic conductivities. For nonsteady-

flow analysis, ground-water storage is simulated by adding a capacitor at each intersection of resistors.

Figure 4 shows a completed model being analyzed. The model has been hung in air to reduce electrical leakage around high-resistance elements. Cabinets at the left and right edges of the model contain analyzer and other control equipment. A curve representing head versus time at a given point in the aquifer is being observed on the oscilloscope screen at the right edge of the photo.

By using small capacitor values to represent aquifer storage and large resistance values to represent hydraulic conductivity, a model-time interval of 1 second might represent, say, 10 years in the aquifer system. A permanent record of the curve for head versus time or drawdown versus time may be obtained simply by photographing the oscilloscope trace after connecting this instrument to a model point of interest.

The cabinets in Figure 5 house a grid of variable resistors and regulated voltage and current supplies, designed and constructed as part of the research on steady-state analogs. The equipment was designed especially for the study of steady flow through nonhomogeneous aquifers. Solutions for selected hypothetical flow problems, showing the head distribution in aquifers of specified shapes and nonhomogeneities, have been worked out with the equipment. These solutions have been used in the Branch's employee-training program and for testing numerical (iteration) techniques of analyzing water-level data.

At the present time the analyzer equipment in use by the Ground Water Branch is inadequate for easy study of the extremely complicated nonsteady-flow systems. However, as the demand for flow analyses increases, equipment is being augmented in both quantity and quality, thus keeping the analytical capacity and accuracy of the analog work at a maximum commensurate with current demand and funds. Paralleling the improvements in analyzer equipment, a continuing search is underway for lower cost modeling techniques. All models now being constructed for routine nonsteady-flow analysis are made by assembling conventional fixed resistors and capacitors. Research on new types of components has shown some promise toward reducing model size and component cost.

What's the Use?

The equipment shown in Figure 5 was part of the Geological Survey's exhibit at

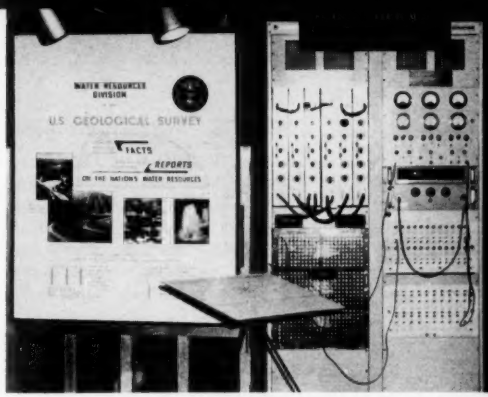

Figure 5. Model unit constructed of variable resistors and regulated voltage and current supplies, for analyzing steady flow through nonhomogeneous aquifers.

the meeting of the National Water Well Association, held at Washington, D.C., in October 1958. A commonly encountered problem—flow from a stream to a well—was set up to illustrate use of the steady-state analog equipment. The writer had the opportunity to explain its use and advantages to several interested—and interesting—visitors, one of whom approached the display and inquired into the nature of this machine. After patiently listening to a 3-minute discourse on what the equipment represented and on the manner in which it could be used, the visitor asked, "How do you get it down a well?" The writer, assuming that the question was not facetious, offered the explanation that this was not a field instrument, but was used only in the laboratory for analyzing problems of water flow. Being a practical man, the visitor carefully reexamined the cabinet housing and countered with, "Where do you put the water in?" Obviously proper rapport was not being established, and more explanation seemed necessary. A sample flow net of the area between the well and stream illustrated on a drawing nearby was used to support a more detailed explanation. The visitor listened patiently to the longer explanation and as it was concluded offered the climaxing remark, "Well, this can't be of any practical use because everybody cases off that surface water and goes deeper to get a safe supply."

The visitor was absolutely correct in looking for the element of practicality because analog models can be applied impractically, like any other method of analysis that might be used in hydrology. The knowledge to be gained from the analog model is no more valid than the completeness and precision of the field data or the

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One hundred and one years of achievement . . .

THE GEOLOGIST ASSOCIATION of GREAT BRITAIN

by OSWALD C. FARQUHAR [1]

In the recent film version of Jules Verne's "*Journey to the center of the earth*", the Edinburgh Professor was described as belonging to the Royal Geological Society. However, no society of this name has ever existed and mention of it was merely poetic license on the part of the scriptwriter. But as a prominent Scottish scientist of the 1870's the Professor in real life would have been a Fellow of the Royal Society of Edinburgh. Also, as a professional geologist he would be a Fellow of the Geological Society of London, the principal organization of British geologists, founded in 1825 and now having a fellowship of about 2330. By comparison the Geological Society of America, founded in 1888, presently has some 5100 fellows and members. One other group of mainly British geologists is the Geologists' Association, and it is the aim of this article to describe some of its activities.

The Geologists' Association has about 2100 members, the majority living in the London area, and it was founded in December, 1858, so that at the time of writing 101 years of operation have been completed. To commemorate the centenary a book telling the story of the association's first hundred years was issued in 1958.[2] This book was listed in a few U.S. periodicals and reviewed in others. But in the 18 months or so since its publication only three copies have been sent to addresses in this country not on the regular mailing list, although other copies may have found their way here indirectly. Various contributors to the centenary volume have recorded different aspects of the association's history, and have made some useful comments on its special functions in the geological world.

The Geologists' Association was started primarily for amateurs interested in the earth sciences, and has remained essentially the same in character throughout the 101 years of its existence, although the proportion of amateurs has declined as compared with the total membership. Fewer than twenty of the members reside in North America. Unlike some otherwise comparable institutions that have junior associates, there is no age limit up or down, and in 1862 one enthusiastic father even had his 7-year-old son enrolled as a Life Member!

The President of the Association is chosen alternately from the ranks of professionals and amateurs, a happy arrangement that has been carefully followed except in 1930. In that year the Council asked Professor W. W. Watts to continue in office in order to resolve a struggle between the conservatives and the progressives, particularly over questions of balloting and publications.

The nature of the meetings has evolved successfully because it has been appreciated that there are other ways of imparting technical information besides the formal lecture. Thus many papers accepted for publication are 'taken as read' and not presented orally to the general membership. Those who know themselves to be poor speakers do not have to face up to a public lecture to have a paper accepted, and those who are known to be poor speakers are not necessarily invited to lecture, although their papers may still be accepted.

The times of the meetings reflect the changes in habit and habitat of members in the London area. In the 1880's the meeting were at 8 p.m., later at 7 p.m. and more recently at 6 p.m. The earlier hours were called for as many Londoners came to live farther afield, commuting from the outer suburbs. Most people working in the city want to get home instead of hanging around for another meeting. However, occasionally there used to be special dinners, particularly after the annual reunion. At

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[1] DR. OSWALD C. FARQUHAR, Associate Professor of Geology, University of Massachusetts, Amherst, Mass.

[2] G. S. SWEETING, Editor (1958): "*The Geologists' Association, 1858-1958*". Benham and Company, 12, Culver Street, Colchester, England. *(GeoTimes, vol. IV, no. 2, p. 30.)*

one time these were followed by dances continuing until after midnight, although such merrymaking was discontinued in the late 1920's.

The original purposes of the association were to hold meetings for the presentation of papers and for the exchange and exhibition of specimens, as well as to have a library, museum, excursions, courses of lectures, and various local activities. The organized exchange of specimens is no longer practicable, and, as there are other well-stablished exhibits in London, no museum is operated by the association. In other respects the original purposes have been followed through witl. enthusiasm and benefit. A conversazione each autumn at which among other things members and friends display their choicest materials has been proving an attractive feature of the association's annual program, as has the arrangement of symposia in recent years.

The Geologists' Association enjoys a cordial relationship with the Geological Society of London, and G A meetings nowadays are held in the GSL's library and meeting rooms in Piccadilly. Overhead for the G A always has been low with no permanent meeting place, no paid officers, and the book and map collections for many years housed free on a mutual use basis in London's University College.

In many ways the GSL is senior to the G A, but, as one of the writers in the centenary volume has noted, this is not always apparent. In fact there have been times when a newly fledged former student has had a paper published in the Journal of the GSL in the same year that his past professor and mentor has had one included in the Proceedings of the G A.

The G A places great emphasis on field excursions. There is ample scope for these as every formation, even the elusive Miocene, is well represented in the British Isles, and there are plentiful examples of almost all types of igneous and metamorphic rocks, even the exotic eclogite. With a literally wonderful coastline and with splendid highland topography the whole country offers a lot to the interested field geologist, professional and amateur alike.

Whole-day and half-day field meetings are held regularly on Saturdays in the summer months within a 60-mile radius of London. Then, at Easter, Whitsun and in mid-summer, week-end and special field meetings are organized. These extend from two to fourteen days and are usually to more remote localities, such as the Isle of Wight, Devon, Cornwall, the Scilly Isles, Bristol, the Malvern Hills, Shropshire, Charnwood Forest, Wales, the Lake District, the Scottish Highlands, and the Orkneys and Shetlands. Here one must also mention the 20 mile by 8 mile Isle of Arran off the Scottish west coast in the Firth of Clyde. This little place is like time in a nutshell, or at least like Great Britain in miniature, for it contains within its narrow borders instances of almost every phenomenon in earth history and representatives of nearly the entire stratigraphic column.

Many excellent excursions have been held abroad, some in conjunction with foreign societies. Those in the Alps, the Pyrenees, Norway, Czechoslovakia, and Eire have been particularly successful. Special excursions for ladies were suggested many decades ago, but never run. There is, of course, no reason why ladies should not have a separate program if they wish, in the same way that Ladies and Gentlemen split into two groups for annual dinners at some large conferences. But in the matter of field excursions the ladies of the G A are very much the equals of the men. Members may wear the association's silver and gold lapel badge which simplifies rendezvous at such places as railroad stations.

The name 'excursion', incidentally, has been changed recently to 'field meeting', the latter denoting more serious intent and thus aiding the tax situation by enabling certain deductions to be claimed. The G A ran 65 special field meetings in connection with the 1948 International Geological Congress in London, and the published reports of these and many other trips are of considerable value to members. Recently a whole series of field guides, especially to areas around university towns, has been begun.

The Proceedings of the Geologists' Association are issued quarterly and cover the hard core of the subject, namely physical geology, stratigraphy, paleontology, petrology, and structural geology. At one time there was a good deal of vertebrate paleontology, but most of this now goes to other journals. Likewise the association never began publication in the specialized fields of geochemistry and geophysics. There has always been a lot on some aspects of archeology, especially flints. In the 1860's the majority of the papers were on the Quarternary. Two subjects that have constantly received attention are the London basin and the Permo-Triassic boundary. The proceedings also print meticulous biographies of many of the association's deceased members, and, for those who care to read them, many of these obituaries are a source of inspiration. In a good year the proceedings run to four or five hundred pages.

(Continued on page 34)

A report on THE HIGHWAY GEOLOGY SYMPOSIUM

About 150 geologists and engineers gathered at the University of Tennessee in Knoxville, on February 10, for the Twelfth Annual Highway Geology Symposium, which was co-sponsored by the University of Tennessee, The Tennessee Department of Highways, and the Tennessee Division of Geology, with assistance from local members of the Tennessee Valley Authority and the U. S. Geological Survey, under the general guidance of Robert A. Laurence, Local Chairman. Eleven papers (a list of which appeared in January-February *GeoTimes*) on a wide variety of subjects in the field of highway engineering, provided the main course. Those who arrived early were entertained on Thursday evening by a group of Tennessee producers and contractors at an informal gathering at a downtown hotel. About twenty stayed over on Saturday to visit the laboratories of the Tennessee Highway Research Program, a joint project of the University and the Tennessee Department of Highways. High point of this demonstration was the skid-testing equipment, which had been discussed by William A. Goodwin on Friday.

Those who attended the Symposium came from Puerto Rico and Oregon, from Florida and Pennsylvania and many places in between. This indicates that there is widespread interest in the field of Highway Geology, and the Symposium seems firmly established as a permanent meeting of National scope. Next year's Symposium will be held at Phoenix, Arizona, under the sponsorship of the Arizona Highway Department and Arizona State University on March 16, 1962. Lewis E. Scott is the local chairman, and inquiries may be directed to him.

This year's Proceedings will be published as a bulletin of the University of Tennessee Engineering Experiment Station, and will be available before the end of 1961. See *Books* for reference to 1960 Proceedings.

Proceedings of the first 10 meetings of the Symposium on Geology as applied to Highway Engineering are now available, according to Ian Campbell, a member of the Steering Committee.

The Proceedings cover a wide range of topics that are of special interest to geologists. These volumes contain a wealth of basic information on geology and its applications. Numerous papers by authors from widely scattered parts of the United States are included in the set.

The 3-volume hard-cover set is 8½ x 11, offset-printed from double-spaced copy. The cost of the set is $15.00, with a special rate of $12.50 to educational institutions. Checks should be made payable to "Treasurer, State of Virginia," and should be sent to Mr. W. T. Parrott, Virginia Department of Highways, Richmond, Virginia.

Utah Geology Department Offers Summer Program For High School Boys

The Department of Geology, University of Utah, has received a grant from the National Science Foundation to support a 6-week field-laboratory program in geology for 25 junior and senior high-school boys with proven ability and interest in geology. Participants will be housed in dormitories on the University campus; the group will travel by chartered bus and will camp out on all overnight field trips. Students will provide part of their subsistence, but all other costs are covered by the NSF grant. Dr. Wm. Lee Stokes is director of the program and Dr. Daniel J. Jones and Dr. Richard L. Threet will participate in supervision and instruction. The program, which commences July 25, will be built around weekly field trips to areas of geologic significance in the vicinity of Salt Lake City. Among the areas to which visits are planned are Zion and Grand Canyon National Parks, the Wasatch Range, Uinta Basin, Craters of the Moon and Bonneville Flats. Geology in and en route to these areas will be followed on topographic and geologic maps, and the taking of notes and systematic collection of specimens will be required. On-campus laboratory and library work will be intensive and will center chiefly on problems pertaining to the field trip areas. It is intended to visit geologists, geophysicists and mining geologists in the field and to see first-hand the types of investigations carried on by earth scientists.

This type of program will not duplicate or infringe upon the usual high school or college course and is aimed at giving potential geologists a more realistic view of the profession than is possible from textbooks and indoor work.

It is hoped that readers of *GeoTimes* will bring this notice to the attention of acquaintances who may qualify for acceptance in the program. Applications should be sent to *Wm. Lee Stokes, Department of Geology, University of Utah, Salt Lake City, Utah.*

BIG HORN FLOAT TRIP

Planned by Billings Society

The Billings Geological Society announces that the Annual Field Conference for 1961 will be a float trip on the Big Horn River through the Big Horn Canyon, starting near Kane, Wyoming, and ending at the site of the projected Yellowtail Dam in Montana, 30 miles south of Hardin, Montana. The trip through the Canyon affords observation of excellent exposures of the sedimentary section from the Cretaceous to the Cambrian, as well as structural elements of the Big Horn and Pryor Mountains. The trip is particularly timely, as many of these exposures will be inundated upon completion of the dam. The BGS Fifth Annual Field Conference Guide Book, 1954, covers the geology of the areas adjacent to the canyon. Those desiring to review the geology prior to the trip may obtain copies through Petroleum Information, 111 North 30th Street, Billings, Montana; price $7.50. A party of Smithsonian archeologists will be working in the area during the field season and the Society hopes to arrange for a fireside talk on that subject.

The trip will be made in inflatable rafts with six men in each eight or ten man raft and three in the six man size. Each boat will transport its occupants' sleeping bags and gear and each boat crew will be responsible for providing and cooking their own food. State law requires that each man be provided with a life jacket.

The Society regrets that the trip will be for men only. It is hoped that those interested will make reservations at the earliest possible date in order that sufficient boats may be obtained to accommodate everyone desiring to participate. Reservations will close on May 8th. In the event that registration exceeds the number that available boats will accommodate, the reservations will be on a first come, first served basis. However, any group that can provide their own inflatable boat, six man size minimum, and equipment, will be welcome to join the flotilla. Transportation to and from the river for visitors arriving in Billings by air or rail, will be arranged by the Society. Reservations and registration for those arriving by car can be handled either at Billings or Lovell, Wyoming.

Additional information on the trip will be available at the AAPG Annual Meeting at Denver, or may be obtained by writing the *Billings Geological Field Conference Committee, P.O. Box 884, Billings, Mont.*

Pictures by the U. S. Bureau of Reclamation.

The BGS float trip starts where the Big Horn River enters the south end of the Pryor Mountains at the base of the hills in the center background.

The Big Horn Canyon trip will end at the Yellowtail dam site.

A view into the Big Horn Canyon to be traversed on the raft trip.

The Relationship of Geologists & Engineers In Planning Public Works Projects[1]

by HARVEY O. BANKS[2]

The progress of engineering geology within the last few decades has been remarkable indeed. This progress can perhaps be exemplified by a review of the activities of the California Department of Water Resources since 1928. In that year the importance of engineering geology burst upon this State with the catastrophic failure of Saint Francis Dam. That disaster resulted in statutory enactments which assigned to the Division of Water Resources supervisory control of all dams in the State above a certain size, excluding those federally-owned. At that time there was only one engineering geologist employed by the State. At present over 900 dams are under state jurisdiction, and geologic investigations of dam sites and other added activities have resulted in increasing our staff of geologists to eighty-five.

At the close of World War II came an influx of population in California, with new arrivals increasing from 99,000 persons who entered during 1946 to 298,000 during 1959. As a consequence, water shortages which already existed were severely aggravated. Housing developments grew like mushrooms, expanding to include desert waste lands and unstable hillsides. Transportation facilities were strained, and construction in general accelerated beyond all expectations.

In 1947, the Division of Water Resources began an inventory of the State's water resources and an analysis of water requirements, both present and future, which indicated that California's water resources are sufficient to supply her needs. The solution to water shortages lies in the capturing of surplus flows that exist in parts of the State, providing regulatory storage and finally distributing these surpluses to areas of deficient natural supply. It was determined that the construction of some 270 new dams and many hundreds of miles of canals, tunnels, laterals and pipelines would be required to accomplish this purpose. This statewide water supply system, known as the California Water Plan, presented many complex problems involving both geology and engineering.

Some of these problems are worthy of review inasmuch as they are indicative of the challenge to engineering geology that has arisen in recent years. As an illustration, the investigation of 270 new major damsites and reservoirs in itself poses no small problem, but this problem is even further complicated because dams have already been constructed at many of California's obviously good sites. At those sites remaining, the geology is usually complex or obscure. Furthermore, the great demands for storage require that we consider the highest dams that can be safely and economically constructed at these complicated sites.

A ramification of the storage problem developed when preliminary investigation of available dam and reservoir sites showed that sufficient storage to implement the California Water Plan could not be provided economically through construction of surface reservoirs alone. Adequate storage could be provided economically only through operating ground water basins in conjunction with surface reservoirs. Knowledge of the physical characteristics of California's 273 ground water basins and related problems such as recharge, water quality, salt balance, sea water intrusion, sewage and industrial waste disposal, and garbage and rubbish disposal therefore becomes of paramount importance.

Another problem arose in connection with early aqueduct routing studies. These studies indicated that any route from Northern to Southern California must traverse seismically active regions including one or more crossings of the San Andreas fault. The danger of destruction of engineering structures located on active faults

[1] Condensed from address by author at the Third Annual Banquet of the California Association of Engineering Geologists, October 14, 1960.

[2] HARVEY O. BANKS, Director of California Department of Water Resources when the address was presented recently retired from state service and is now associated with the firm Leeds, Hill & Jewett, of San Francisco.

as a result of offsetting is obvious as is the danger of damage from seismic shock. Less apparent, though equally real, is possible impairment of canals through crustal distortion. In regard to this last effect, it was observed that, following the Montana earthquake of 1959, the shoreline along Hebgen Lake had been tilted several feet, and in Chile, as a result of the recent earthquakes in that country, regional depression of many feet has occurred. Since our large aqueducts are being designed with a gentle gradient of about one foot in four miles, it is apparent that crustal distortions considerably less spectacular than those observed in Montana or Chile could seriously affect their hydraulic characteristics. The need for delimiting areas of potential crustal strain in routing canals is therefore apparent. The development of techniques and instruments to accomplish this task fell to our engineering geologists.

These problems, which I have described in all-too-brief terms, are but a few of many, too numerous to discuss at this time. Their immediate effect on the Department of Water Resources has been the increase in staff from one geologist in 1927 to 85 in 1960 that has been mentioned. Perhaps even more significant is the effect upon the relationship between engineers and geologists, and it is these relationships that I would like to discuss.

Geologist-Engineer Teams

At the moment, the Department of Water Resources is engaged in thirty-seven investigations involving both geology and engineering, and it has been interesting to analyze the relationships between geologists and engineers within the several groups working on these projects. Some of these groups operate more harmoniously than others and a mutual respect has developed between the geologists and the engineers. In these instances, it has been observed that geologists' activities are usually not limited to geology, but that geologists and engineers work together attacking problems as a unit. A mutual interest in each other's profession has developed, and, in short, a healthy organizational environment exists which is producing better results.

I have selected two of several possible examples to illustrate this team approach, as we call it. An important mission assigned our Southern California District Office was the selection of the best route or combination of routes for an aqueduct system to convey Feather River Project water to Southern California. Early "paper" locations showed that there were about sixty possible combinations to be considered, each with some merit. Some of these proposed alignments could be rapidly eliminated. The comparison of alternatives necessitated preparation of reasonable cost estimates for each alignment and the consideration of so-called intangible factors, i.e., those which could not be reduced to dollar values for comparison.

Rapid methods for estimating the costs of tunnels and canals were needed to effect the cost comparisons, and sound judgment was required to analyze the intangibles. A team of geologists, engineers and consultants, including a consulting geologist, was formed to devise cost estimating procedures and to appraise those factors which could not be reduced to dollar values.

This team conferred with construction firms, equipment manufacturers, explosives distributors, mining engineers and steel fabricators. Analyses were made of 91 modern tunneling projects and many canals. Geologic conditions along these projects were correlated with cost controlling factors such as rates of tunnel heading advance, explosives, steel support, drill steel, and dewatering experiences. Explosive specialists were shown outcrops of various rock types and their opinions solicited as to the quantities of explosives that would be required to excavate tunnels and canals of various dimensions through these formations. Consulting construction engineers were shown these same outcrops and their views in turn obtained with respect to construction techniques, expected progress rates, equipment requirements, and current unit costs. Prevailing wages, bonuses and overtime provisions were obtained from labor union officials. Finally, all these data were woven into a simplified system of curves and charts from which a cost estimate could be obtained rapidly, once the geologic conditions along a particular route were reasonably established.

In another instance, the feasibility of constructing a tunnel through the Coast Ranges near Pacheco Pass was to be considered. An alignment was selected, the geology mapped, and a suitable preliminary design obtained. There remained the question of construction cost. A team of seven, including geologists, civil engineers, estimators and one consulting construction engineer was formed. This group inspected the route in the field, after which the problem was discussd at length in conference. Using maps, charts and other available data, the various problems posed by the estimate were attacked one by one, the

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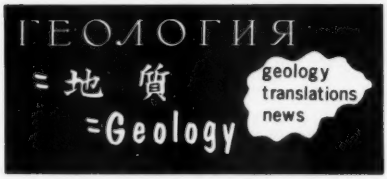
GEOLOGY in the Public Eye

by Robert L. Bates

Department of Geology, Ohio State University

"Instead of joining a service club as a civic duty," writes J. C. Manning of Bakersfield, Calif., "several of us are acting as science consultants to the schools. What we are trying to do is to put more science into the elementary classroom, and in our region earth science is a natural." Already in print is a 12-page field-trip booklet, issued as a curriculum bulletin of the Kern County school system. Others are planned. Manning also teaches an evening course on the geology of California, for school teachers, at the Bakersfield center of Fresno State College. . . . In February and March, 300 selected high school students attended a series of four lectures at the Davis campus of the University of California. The first lecture was by Don Emerson of the geology department. His subject, "Petrology Studies Mountains with a Microscope," was illustrated with projected photomicrographs of thin sections. Geological materials were also on display. . . . Did you know that an annual Geology Day is observed in the Republic of Mexico, and has been for 15 years? On *"El Día del Geólogo"* for this year, there was a dinner attended by 120 persons. Guillermo P. Salas, director of the Instituto de Geología, announced the establishment of a department of sedimentology and marine geology at the University. An illustrated story in the Mexico City paper *Excelsior* for Jan. 7 was sent in by Lloyd Staples. . . . The Elementary School Science Bulletin for February contained illustrated articles on fossils, mineral identification, ground water, and indoor geology. Authors were, respectively, N. Hotton and G. Switzer of the U.S. National Museum; I. E. Odum of the Illinois Survey; and H. Schneider of the City College of New York. . . . According to the Hartford (Conn.) *Courant* for Jan. 24, Prof. R. L. Brown of Southern Connecticut State College believes fragments picked up in the vinicity last year are chips knocked off the moon by Russia's Lunik II. The professor teaches earth science, it says here. "Some of the fragments lost weight after being found," owing to "the effect of radiation in outer space." But now they "have regained about 75 percent of their weight." This is certainly reassuring.



"Lost—One Third of the World's Scientific Literature" is the title of a nine-page booklet issued by the National Science Foundation. According to it nearly 30 percent of the world's scientific literature is published in languages which can be read by less than 5 percent of U.S. scientists. Less than 2 percent can read any one of the following: Russian, Japanese, Italian, Polish, or Chinese—languages in which 28.7 percent of the literature of chemistry for 1958 was published.

To what extent does this situation apply in geology? It appears that we are "about par for the course." The AGI Translations Office has definite information on only about 225 U.S. geologists with a working knowledge of scientific Russian. The number capable of reading Chinese is unknown, but an educated guess is that there are probably less than 50. Even our capability for keeping up with research published in French and German could be questioned, for out of 15,654 earth scientists in the National Register of Scientific and Technical Personnel, 1956-1958, less than 700, or about 4 percent, have a high degree of proficiency in one or the other.

Geologists concerned with the implications of the problem should read the NSF booklet. Although it covers the problem in terms of science as a whole, one needs only to substitute the term "geology" in most instances and the shoe will fit. (Address request for publication NSF 60-20 to Foreign Science Information Program, Office of Science Information Service, National Science Foundation, Washington 25, D. C.)

The first deliveries have been made of Russian scientific and technical publications translated abroad as part of a cooperative Federal agency program financed by the overseas sale of surplus U.S. agricultural commodities—the Public Law 480 program. Translations produced under the P.L. 480 contracts, concluded so far with Israel, Poland, and Yugoslavia, are made available to scientists by deposit in research libraries and by sale through the Office of Technical Services, Department of Commerce, Washington 25, D. C. Comprehensive listing of the translations appears in *Technical Translations*. Items of most prob-

Geologists Make News at Recent AIME Meeting

Above. Geologist J. L. Gillson (right), retiring president of the American Institute of Mining, Metallurgical & Petroleum Engineers hands the gavel to his successor R. R. McNaughton. Dr. Gillson is a past-president of the American Geological Institute.

Center. Geologist Donald H. McLaughlin (left) accepts the certificate of the Rand Gold Medal from President Gillson *in recognition of his distinguished career as an administrator in mining and scientific education and as an outstanding executive in many segments of the mining industry, and as an adviser to government.* Dr. McLaughlin is Chairman of the Board and Chief Executive Officer of the Homestake Mining Co.

Below. Vincent D. Perry (right), Vice President and Chief Geologist of The Anaconda Company accepts the AIME Society of Mining Engineers' Jackling award from Reno H. Sales, Consulting Geologist, *for his contributions to geology and geophysics, his leadership in their application to the finding and developing of mines and for his lecture "The Significance of Mineralized Breccia Pipes."*

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able interest to geologists are listed in the "Reference Section" of *International Geology Review.*

AGI gets the message . . .

COMMITTEE OF 1000 FOR AGI GROWS

AGI
feels urgency
for performance evidenced
by
contributions of 600 members
of
Committee of 1000 for AGI
1961

AGI feels there is a strong message of urgency to do more to advance geology and the welfare of geological scientists and to do it more effectively evidenced by the spontaneous and very significant financial support coming from the more than 600 persons who in the last two months have joined the COMMITTEE OF 1000 FOR AGI—1961. With the 416 names listed in this issue added to the 191 persons listed in the March issue, membership in the Committee of 1000 now tops 600 and continues to grow.

You can add your name to the Committee of 1000 by contributing $10 or more to support of AGI and its activities. If you cannot join this group, you still may wish to be one of those several hundred persons who have contributed a lesser amount to the work of the Institute.

The membership of the Committee of 1000 for AGI—1961 is very selective; this membership is restricted to those who feel AGI's role in advancing geology and the geological sciences is sufficiently important that they will dig into their pockets to support it. Although it is selective in this one respect, it is not discriminatory in other ways. Numerous of its members are students or recent graduates while others are well-known leaders of geology. There is also a significant number of "friends of geology"—these persons are non-professionals who appreciate geology as an avocation.

Recent additions to the Committee of 1000 for AGI-1961*

John Albanese
Roger G. Alexander, Jr.
William H. Allen
Royce E. Anderson
Norman R. Anderson
William Evert Andrau
H. K. Armstrong
Chester A. Arnold
C. H. Atchison
Matthias E. Bachman
Edgar H. Bailey
Billie M. Baird
R. S. Ballantyne, Jr.
Norval Ballard
W. F. Barbat
Thomas D. Barber
Clifford A. Barkell
Farrell F. Barnes
Wm. B. Barnhill
Charles R. Barr
Edward Barrett
L. T. Barrow
John G. Barry
Jackson M. Barton
Charles C. Bates
Melvern F. Bear
B. W. Beebe
Terry V. Bills, Jr.
E. L. Birmingham
Barton P. Bishop
D. L. Blackstone, Jr.
Morton K. Blaustein
Kenneth G. Boling
Ygnacio Bonillas
Dan E. Boone
Margaret F. Boos
E. Borax
W. T. Born
James Boyd
O. S. Brace
R. D. Brace
Malcolm K. Brachman
Jules Braunstein
Frank M. Brooks
Joseph P. Brennan
John F. Bricker
Donald M. Brown
Glenn A. Brown
Edwin C. Buffington
F. H. Burge
Edward M. Burt
Gerald J. Bush
William S. Butcher
C. W. Byron
David C. Callaway
E. R. Campbell
Keegan Carter
Kenneth E. Caster
H. E. Christensen
Willard J. Classen
Preston E. Cloud, Jr.
John R. Coash
James C. Cobb
William M. Cogen
George V. Cohee
William E. Colson
Robert M. Condon
Warren L. Coonrad
Leavitt Corning, Jr.
Henry W. Coulter
A. F. Cox
Ben B. Cox
Kenneth J. Cox
Walter M. Cox
Kenneth H. Crandall
G. W. Crickmay
Aureal T. Cross
John F. Curran
Trent R. Dames
Carle H. Dane
Edward A. Danehy
L. Raymond Dawson
T. A. Dawson
David F. Demarest
John M. Denoyer
Norman M. Denson
Chester L. Dodson
C. A. Doll
Erling Dorf
H. S. Doty
F. A. Douglass, Jr.
James C. Doyle

* Listed here are 416 members added through March 9, 1961, to the original list of 191 members published in the March issue of GeoTimes.

Donald C. Duncan
Arthur N. Dusenbury, Jr.
Everett C. Edwards
M. G. Edwards
Norman W. Elton
John E. Elliott
Brooks F. Ellis
N. W. Engel
Rene L. Engel
John S. England
Charles E. Erdmann
William D. Fairchild
Oswald C. Farquhar
Julian W. Feiss
O. S. Fent
John H. Feth
William O. Field
Joseph R. Finerty
D. Jerome Fisher
E. P. Fisk
Robert D. Fitting
Carlos F. Fleischmann
F. W. Floyd
Fred Foreman
H. S. Forgeron
Francis H. Frederick
David C. Fransen
Xavier M. Frascogna
Carl Fries, Jr.
Jack Frost
Roy P. Full
Richard E. Fuller
Frederic W. Galbraith
John E. Galley
A. J. Galloway
S. S. Galpin
William I. Gardner
W. H. Geis
George R. Gibson
G. B. Gierhart
J. P. Gill
Waldo S. Glock
M. W. Goering
J. E. Goffman
Robert L. Gollnick
U. S. Grant
Geo. Gardiner Green
Robert Greenwood
A. B. Gross
Dorsey Hager
Dollie R. Hall
H. H. Hall
Roy H. Hall
H. D. Hand
Byron S. Hardie
George C. Hardin, Jr.
George R. Harlow
Wallace T. Harper
Robert L. Heller
W. Dave Henderson
Eiler L. Henrickson
Harold D. Herndon
Wm. B. Heroy, Jr.
Norman Herz
David M. Hill
Lowell S. Hilpert
F. Woods Hinrichs
Floyd C. Hoadley
F. G. Holl
Donald D. Hollar
R. V. Hollingsworth
S. W. Holmes
W. B. Hoover
John W. Huddle
James D. Hume
C. B. Hunt
James W. Hunter
Elvin M. Hurlbut, Jr.
H. S. Igau
R. Denny Jackson
C. E. Jacob
Richard H. Jahns
M. H. Janszen
David E. Jensen
Carlyle D. Johnson
J. Harlan Johnson
Wendell B. Johnson
W. P. Johnston
S. Karrer
F. H. Kate
Godfrey F. Kaufmann
H. Allen Kelley
Joseph M. Kennedy
William S. W. Kew
Edgar W. Kimball
Vernon L. King
Owen Kingman
George deVries Klein
Ira E. Klein
F. L. Klinger
R. S. Knappen
Adolph Knopf
Robert F. Kraye
Medora H. Krieger
Hugo E. Kuehn
Harry S. Ladd
Carl A. Lamey
K. K. Landes
Leonard Latch
Royce R. Latimer
Robert A. Laurence
William N. Laval
Roy P. Lehman
Howard H. Lester
Frank G. Lesure
Wendell L. Lewis
Paul W. Long
William D. Lord, Jr.
Thomas R. Lyons
William D. Lynch
Merrill W. MacAfee
Atlee G. Manthos
James L. Martin, Jr.
Wm. E. McBroom
Royce McCary
Neal E. McClymonds
W. D. McEachin
G. W. McGaha
Ira E. McKeever, Jr.
Edwin T. McKnight
William J. McMannis
Edward W. McRae
J. Hoover Mackin
John F. Magale
John F. Mann, Jr.
Jay G. Marks
U. C. Marquis
Frank L. Marsh
Conrad Martin
Helen M. Martin
J. E. Matter
Riley G. Maxwell
Brainerd Mears, Jr.
Donald J. Melland
Frank A. Melton
William M. Merrill
Phillip L. Merritt
Rex R. Meyer
Willis G. Meyer
Howard A. Meyerhoff
Wilson D. Michell
Richard C. Mielenz
Robert P. Miller
Watson H. Monroe
H. L. Moore
John I. Moore
T. G. Moore
Harold T. Morley
James L. Morris
John W. Mrock
Garrett A. Muilenburg
Grace Muilenburg
Siemon Wm. Muller
Haydn H. Murray
Raymond L. Nace
Lloyd A. Nelson
L. L. Nettleton
Sherman K. Neuschel
William W. Newton
I. K. Nichols
P. B. Nichols
O. W. Noland
L. A. Norman, Jr.
K. B. Nowels
George E. Nowotny, Jr.
Jerome J. O'Brien
Ira D. Odgers
Henry R. Ohlen
Frank C. Osment
R. N. Ostrander
Herbert Parker
E. A. Paschal
Max Passante
John B. Patton
William W. Patton, Jr.
Raymond E. Peck
J. R. Pemberton
E. N. Pennebaker
A. R. Perko
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Vincent D. Perry
R. A. Peterson
Richard Phillips
Ross M. Phillips
William G. Pierce
Darrell M. Pinckney
C. W. Pitrat
J. S. Pittman, Jr.
E. R. Pohl
R. R. Porterfield
Paul H. Price
William E. Price
Harry Ptasynski
Paul S. Pustmueller
F. H. Putlitz
William M. Quackenbush
Gilbert O. Raasch
Wallace Ralston
John R. Rand
Robert E. Rankin
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M. W. Redhead
R. G. Reese
Eugene F. Reid
A. L. Repecka
Roger Revelle
H. W. Reynolds, Jr.
Geo. D. Riggs
Robert J. Riggs
R. E. Roark
Fred B. Roberts
Homer E. Roberts
M. C. Roberts
Heath M. Robinson
Henry Rogatz
Joseph L. Rosenholtz
Robert Roth
John T. Rouse
Robert W. Rowland
Willard W. Rusk
R. Dana Russell
J. F. Schairer
Henry R. Schmoll
W. T. Schneider
R. F. Schoolfield
J. Paul Schumacher
Edward W. Scott
V. C. Scott
A. Selig
L. J. Severson
Paul R. Shaffer
B. Douglas Sheffer
James W. Sheller
Francis P. Shepard
Robert R. Shrock
R. L. Sielaff
Jack A. Simon
John T. Sinclair, Jr.
Frank Slavik, Jr.
Gordon Smale
A. L. Solliday
Ronald K. Sorem
Arthur H. Sorensen
Dudley P. South, Jr.

(Continued on next page)

COMMITTEE OF 1000 FOR AGI—1961

Continued

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Harry R. Stenson	C. A. Warner
Harris B. Stewart, Jr.	Douglas F. Warner
Sam Stewart	R. W. Watchous
Raymond J. Stipek	A. C. Waters
Richard D. Stowell	Lewis G. Weeks
R. M. Swesnik	Warren B. Weeks
Glenn C. Tague	Malcolm P. Weiss
Anthony J. Tamborello	William G. Weist, Jr.
Donald B. Tatlock	Francis G. Wells
Spence T. Taylor	John E. Welsh
Arthur R. Thayer	Robert F. Werner
Chas. V. Theis	Jerome Westheimer
Wayne Thomas	E. P. Wheeler, 2nd
C. L. Thompson	J. F. White
L. O. Thompson	R. D. White
Sam Thompson, III	Robert T. White
H. W. Thoms	Robert O. Wilbur
Harry L. Thomsen	Lorna C. Wilkie
E. W. Thorp	Herbert E. Williams
Betty Tinklepaugh	Leslie E. Wilson
John W. Tlapek	Richard F. Wilson
S. W. Totten	R. M. Wilson
Harry A. Tourtelot	R. R. Wilson
R. M. Trowbridge	C. E. Winn
George Tunell	Jay P. Wood
F. S. Turneaure	H. H. Woodard
John W. Vanderwilt	R. D. Woods
Earl C. Van Horn	E. V. Woolsey
Jack R. Van Lopik	E. A. Wyman
J. H. Van Zant	Herbert A. Young
Leo Vesenmeir, Jr.	Richard A. Young
James D. Vine	Wilber H. Young, Jr.
George D. Volk	Basil B. Zavoico
C. Richard Wagner	James H. Zumberge

Geochemical Exploration Course

The Colorado School of Mines has announced an intensive course in Geochemical Exploration, as applied to ore metals, Golden, June 5-16, 1961. The course will involve field and laboratory studies. Enrollment will be limited. For information write *Harold Bloom, Dept. of Geology, Colo. School of Mines, Golden, Colorado.*

INVEST 3¢ A DAY IN GEOLOGY

Become a member of the AGI Committee of 1000 for 1961.

AGI Announces International Institute Participants

Classic features of the geology of the British Isles will be studied during the coming summer by a group of twenty American college and university teachers of geology in the International Field Institute sponsored by the American Geological Institute under a grant from the National Science Foundation (*GeoTimes, Jan-Feb. 1961, p. 14-17).* The Directors of the Institute will be Professor F. H. T. Rhodes of the University of Wales and Professor Paul R. Shaffer of the University of Illinois.

Twenty participants have been invited to attend the institute and a group of alternates also was chosen by the Selection Committee from a field of over one hundred applicants. The Selection Committee was named by the AGI Executive Committee with assistance from the AGI Education Committee and the National Association of Geology Teachers, an AGI Member Society.

The participants selected are listed as follows:

Marvin J. Andresen	Univ. of Alaska
Donald L. Ballmann	St. Joseph's College
Roger L. Batten	Univ. of Wisconsin
W. Charles Bell	Univ. of Texas
James C. Brice	Washington Univ.
John R. Coash	Bowling Green State Univ.
Raymond L. Ethington	Arizona State Univ.
John A. Fagerstrom	Univ. of Nebraska
Ansel M. Gooding	Earlham College
Frank D. Holland, Jr.	Univ. of No. Dakota
Andrew H. McNair	Dartmouth Coll.
Ralph M. Moberly, Jr.	Univ. of Hawaii
J. Keith Rigby	Brigham Young Univ.
Daniel B. Sass	Alfred Univ.
Donald R. Seely	Oklahoma City Univ.
Hubert C. Skinner	Tulane Univ.
Leo A. Thomas	Iowa State Univ.
Chauncey G. Tillman	Virginia Polytechnic Inst.
James W. Valentine	Univ. of Missouri
Donald W. Weaver	Univ. of Calif., Santa Barbara

Public Education is geology's best public relations tool

MANPOWER *in a column —*

By HOWARD A. MEYERHOFF
Scientific Manpower Commission
1507 M Street, N.W., Washington 5, D. C.

According to the National Science Foundation, American industry employed 800,000 engineers and scientists as of January 1959. Now the number is nearer 870,000.

The survey on which the conclusion was based missed only the very small organizations and self-employed professionals. It actually accounted for 764,000 men and women, distributed as follows: engineers, 615,000; chemists, 72,000; biologists, 18,000; earth scientists, 15,000; physicists, 15,000. The remaining 29,000 were either in smaller groups or unclassified. During the calendar year 1958 the number of engineers and scientists industrially employed increased 5 percent.

Other facts and figures brought out by the survey are interesting. Engineers and scientists comprise 3 percent of the total work force. Research and development are the primary activities of 36 percent. The entire group is assisted by 550,000 technicians, which figures out to 0.72 technician per professional.

The authors of the report point out that the annual rate of increase has declined—from 13 percent in 1954 to 5 percent in 1958. Yet funds for research have risen 10 percent per year.

We may grant that equipment costs more than manpower, but it is pertinent to ask whether monetary support for R & D is outstripping the manpower to handle R & D efficaciously.

And can we afford to fall behind in the manpower trained to apply science? Freshman engineering enrollments dropped 11.1 percent in the fall of 1958 and 3.4 percent in 1959. They leveled off in 1960, with a loss of less than 1 percent. Chemistry registered gains but failed to keep pace with the national average in all fields. These two areas of specialization supply 90 percent of the professional personnel in industrial production and operations.

Exploration appears to be the only major industrial activity that was declining at the time of the NSF survey. Its decline has continued. Three-quarters of all exploration personnel are earth scientists, and three-quarters of the geologists in industry are—or were—in exploration, which seems to be the least stable phase of our industrial economy.

Canadian Geophysicists. The newly elected officers of the Canadian Society of Exploration Geophysicists, to be installed at the Annual Meeting in the Palliser Hotel, Calgary, on 27 February 1961 are: front row, (left to right) Jack M. Desmond, Western Geophysical Company of Canada, vice president; Peter I. Bediz, Century Geophysical Corporation of Canada, president. Back row (left to right) Nash H. Miller, United Geophysical Company of Canada, treasurer; Milton B. Dobrin, Triad Oil Company, past president; Rodney J. H. Smith, Imperial Oil Limited, secretary.

NSF Post Doctoral Awards

The National Science Foundation in December 1960 announced the award of 91 senior postdoctoral fellowships and 285 science faculty fellowships. The programs are designed to support advanced research and improve teaching of science, mathematics and engineering in U. S. colleges and universities.

In the senior postdoctoral fellowship program 4.4 per cent of the awards were made to scientists in the earth sciences and in the science faculty fellowship program earth scientists comprised 3.9 per cent of the successful applicants.

The earth scientists receiving the awards follow:

Name, Present Institution, Fellowship Institution

Senior Postdoctoral Fellowship Awards

Clemens A. Nelson, U.C.L.A., U. Oslo (Norway)
Anthony L. Turkevich, U. Chicago, CERN (Switzerland)
Edward J. Zeller, U. Kansas, U. Bern (Switzerland)
John C. Maxwell, Princeton U., U. Florence (Italy)

Science Faculty Fellowship Awards

Donald H. Brice, U. Alaska, U. of Alaska
William Glen, San Mateo, U. of Cal., Berkeley
Lucius T. Grose, Colorado C., U.C.L.A.
Ernest N. Wolff, Colo. State U., U. Oregon
Harold K. Brooks, U. Florida, Harvard U.
Louis N. Kurs, U. Illinois, U. Chicago
William C. Culp, NW La. St. C., L.S.U.
Mildred Berman, Mass. S.T.C., Clark U.
Marc W. Bodine, Jr., Bowdoin C., Princeton U.
Eben L. Johnson, Upsala C., Rutgers U.
John H. Moss, F. and M.C., J.H.U.

SYMPOSIUM ON MARINE MICROBIOLOGY

Chicago, April 20-24, 1961
Morrison Hotel

a review by

Carl H. Oppenheimer [1]

This Symposium will provide a rare opportunity to the geologist or geochemist interested in this growing area of specialization to learn how their fields are interrelated with the habits and activities of the marine microorganisms. The program consists of 65 papers from the world's leading marine microbiologists, is being sponsored by the Office of Naval Research, the Society of American Bacteriologists, and the American Institutes of Biological Sciences. The following summary will help focus attention of geologists and geochemists on the geologic significance of marine microbiology.

Significance of Bacteria to Geological Processes in Shallow Marine Bays: Geolosists attempt to understand the geologic past by what is happening at the present and geochemists are interested in the chemical changes which take place within the sediments. Almost all organic materials, both living and dead, are subject to bacterial attack and ultimate mineralization during microbial metabolism. The energy provided by the organic matter is almost quantitatively transposed during the various processes by which the bacteria affect environment. Therefore, the rate of sediment diagenesis, geochemical changes, and other related processes influenced by bacteria will be directly related to the available source of energy to the bacteria. One area which we do not understand because of insufficient data is the autotropic activity of bacteria whereby they obtain their energy through inorganic oxidation reactions. Many reduced compounds such as ferrous or manganous ions can be oxidized as a source of energy and carbon dioxide is used as a carbon source.

The metabolic activities of microorganisms directly affect the diagenesis of sediments in many ways. Some of these are: by altering compaction processes, solubilization, and precipitation of cations, by changing the redox potential (Eh) and pH, by production of gases, by solubilization and precipitation of carbonates, sulfur compounds, silica, and iron. All of these processes affect the character of the final rock, so that knowledge of what bacteria can do helps us to understand what we see today.

Over the past 70 years microbiologists interested in the marine environment such as Certes (1884), Fisher (1888), Issatschenko (1914), ZoBell, and Waksman, etc., have shown that bacteria are widely distributed over the oceans where the presence of available nutrients and energy provide growing conditions or where dormant forms may persist. Although marine microorganisms function in a manner similar to terrestrial microorganisms, they differ in that they grow in a milieu consisting of an average of 3.4 per cent salts and hydrostatic pressures up to 1100 Atmospheres. Sea water has almost every know element: almost two per cent of the salt is sodium chloride with the other common elements in order of abundance being magnesium, sulfur, calcium, potassium, bromine, and carbon.

Generally speaking, microorganisms found in marine environments are bacteria, fungi, viruses, unicellular algae, and protozoans. These small organisms have one property in common: they are small enough so that they have a large effective surface-to-volume ratio and may fall into the colloidal range. Regardless of the internal function of the cells, the external surface may be affected physically by surface and interfacial tension, oppositely charged colloids or particles, and changes in salt content. The surface effect may overcome the mass or biological activity and the microorganisms can be carried to surface slicks, absorbed to larger particles, clumped together, or precipitated, due to a change in the surface potential. Very little is known about the effects of salts on the colloidal properties of marine microorganisms and especially on metabolism and ion transport through membranes. It may well be that the only difference between a marine microorganism and a terrestrial microorganism is that the former is more efficient energetically and can thus compensate for the osmotic effects of the salts to the cell. The adsorption properties of bacteria favor their persistence in dilute nutrients. Very little organic matter is in solution in the open sea, and a metabolizing bacterium must be attached to particulate food for survival. The charge attraction between the particulate food and the bacterium acts as a concentration factor. Also, inorganic particulate material will adsorb colloids, soluble organic matter, and microorganisms.

[1] CARL H. OPPENHEIMER, Chairman of the Symposium has prepared this report for GeoTimes. He is a member of the Institute of Marine Science, University of Texas, Port Aransas, Texas.

There is considerable controversy over the existence of true marine microorganisms. When bacteria are washed from land into the sea, they immediately encounter the osmotic forces of an increase in salinity. Some microorganisms are killed within a few days or months exposure to sea water. The microorganisms which survive may be precipitated to the bottom, associate themselves with other organisms, or remain independent within the water. They are subject to upwelling, wave action, hydrostatic pressure, concentration on surfaces, action of filter-feeding organisms, or may be adsorbed to the food of larger organisms. Those surviving this ordeal should be entitled to the name marine microorganisms. Some say that a true marine microorganism is one which will grow only in sea water medium. But in fact many microorganisms isolated from the sea will adapt themselves to fresh water medium, and it is not known whether this and other metabolic changes which occur are genetic or adaptation. Regardless of whether there are true marine bacteria or not, the fact remains that the marine environment is populated with marine microorganisms. Either living or dead organic matter immediately becomes covered with bacteria and the influence of microbial activity soon appear.

Bacteria have been found in almost all natural samples of sea water and sediment which have been analyzed. The distribution of microorganisms is quite sporadic following hydrographic features and the presence of available nutrients. Generally, more bacteria are found near land, and especially where the bottom sediments are stirred up. Sediments normally contain several times more bacteria than the overlying water, and thus upwelling, waves, and storms may move the bacteria from the sediments into the water column. In addition, terrestrial run-off adds bacterial populations. Phytoplankton blooms or schools of fish stimulate the growth of bacteria, and even ocean currents have been tentatively identified by their bacterial content, suggesting that discrete water masses have a characteristic attendant microbial population. The open ocean usually contains fewer microorganisms. Although only 7 per cent of the total oceanic area is less than 200 meters deep, it is estimated that the attendant microbiological activity exceeds the remaining 93 per cent of area.

The primary over-all function of marine bacteria in cycles of life in the sea is their heterotrophic role in the mineralization of organic matter from plant and animal life and, of course, the perpetuation of their cells. During metabolism, essential plant nutrients are released into the environment, larger pieces of organic matter are broken down into small pieces, or molecules, oxygen is consumed, toxic hydrogen sulfide is produced, trace elements are concentrated, heat and vitamins are produced, pH is changed, surface active agents are consumed and produced, and many geochemical changes take place. The rate of metabolism depends upon the presence of types of microorganisms, type of organic matter, physical aspects of sedimentary and water environment, pH, Eh, and temperature.

As microorganisms decompose organic matter, the by-products of their activity affect mankind through the deterioration of man-made structures, deterioration of marine food products, and in processes influencing the geochemical environment. Microorganisms play an intimate role in the fouling of submerged surfaces, corrosion of iron, deterioration of wood, rubber, and cordage, and even the destruction of concrete through pH changes. If optimal conditions persist, bacteria will mineralize most organic matter to its component minerals. However, depending on environmental conditions, decomposition may not be complete or more resistant organic compounds are encountered or produced during metabolism which will persist in the sediments in small amounts. It is commonly thought that the hydrocarbons found in recent sediments are those which apparently survive bacterial activity. It has been recently shown that hydrocarbons in recent sediments have the same counterpart in crude oil. The hydrocarbons, present as microscopic droplets in an aqueous sediment may be selectively solubilized by naturally occurring organic solubilizers, transported during water movement and deposited where environmental changes in the formation cause the solubilized material to be released. The droplets will thus coalesce and collect to form larger drops and eventually pools at the top of water. This is one possible explanation for the accumulation of oil from the apparently disperse form in which it was originally produced during geological time.

In summary, one can say that the ultimate basic function of marine microorganisms is similar to that of terrestrial organisms, but that perhaps because of the difference in environment the pathways are different. Man should be interested in understanding the basic mechanisms of marine microbial action which will help him in the future control of microbial metabolic functions which aid and interfere with man's progress and to learn more of the results of bacterial activity.

AGI LONG RANGE CALENDAR OF SCHEDULED MEETINGS AT HOME AND ABROAD

NORTH AMERICAN MEETINGS

1962

Jan. 8-12—HIGHWAY RESEARCH BOARD, Ann. Meeting, Sheraton-Park Hotel, Washington, D.C.

Feb. 7-9—CANADIAN INST. OF SURV. & PHOTOGRAM., Ann. Meeting, Ottawa, Ont., Canada.

Feb. 18-22—AIME: Ann. Meeting, New York City.

Feb. 26-28—AAPG: Rocky Mountain Sect., Salt Lake City, Utah.

Mar. 11-17—ACSM-ASP: Ann. Meeting, Shoreham Hotel, Washington. D. C.

Mar. 20-29—AMER. CHEM. SOC.: 141st Meeting, Washington, D. C.

Mar. 26-29—AAPG-SEPM: 47th Ann. Meeting, Civic Auditorium hdqtrs., Hdqtrs. Hotel, Fairmont Hotel, San Francisco, Calif.

April—EIGHTH NUCLEAR CONGRESS, San Francisco, Calif.

April 23-25—CIM: Annual General Meeting, Chateau Laurier, Ottawa, Ont., Canada.

April 29-May 3—ACerS: 64th Ann. Meeting, New York City.

May 7-8—AIME: Soc. of Petroleum Engrs., 5th Biennial Secondary Recovery Symposium, Wichita Falls, Texas.

May 24-25—AIME: Soc. of Petroleum Engrs., Ann. Joint Meeting, Rocky Mountain Petroleum Sect's., Billings, Mont.

June (1st week)—SEVENTH NUCLEAR CONGRESS, New York City. Write: E.J.C., 29 W. 39th St., New York 18.

Sept. 9-14—AMER. CHEM. SOC.: 142nd Meeting, Atlantic City, N.J.

Sept. 17-20—SEGp: 32nd Ann. Internat. Meeting, Calgary, Atla., Canada.

Oct. 3-5 (tentative)—SOUTHWESTERN FED. OF GEOL. SOC'S., Ann. Meeting, Dallas, Tex.

Oct. 7-10—AIME: Soc of Petroleum Engrs., Fall Meeting, Los Angeles, Calif.

Oct. 31-Nov. 3—GULF COAST ASSOC. OF GEOL. SOC'S., New Orleans, La.

Nov. 5-9—THIRD WORLD METALLURGICAL CONG., Chicago, Ill. Write: Chester Wells, ASM, 7301 Euclid Ave., Cleveland 3, Ohio.

Nov. 12-14—GSA: Annual Meeting, Houston, Tex.

Nov. 12-14—A.P.I., Ann. Meeting, Chicago.

Dec. 26-31—AAAS: Ann. Meeting, Boston, Mass. (tentative).

1963

Jan. 7-11—HIGHWAY RESEARCH BOARD, Ann. Meeting, Sheraton-Park Hotel, Washington, D. C.

Feb. 6-8—CANADIAN INST. OF SURV. & PHOTOGRAM., Ann. Meeting, Ottawa, Ont., Canada.

Feb. 24-28—AIME: Ann. Meeting, Dallas, Tex.

Mar. 24-29—ASP-ACSM: Ann. Meeting, Shoreham Hotel, Washington, D. C.

Mar. 25-28—AAPG-SEPM: 48th Ann. Meeting jointly with SEG Midwestern Geol. Soc., Coliseum, Houston, Tex.

Mar. 31-Apr. 5—AMER. CHEM. SOC., 143rd Meeting, Los Angeles, Calif.

April 22-24—CIM: Ann. General Meeting, The McDonald Hotel, Edmonton, Atla., Canada.

April 28-May 2—ACerS: 65 Ann. Meeting, Pittsburg, Pa.

May 23-24—AIME: Soc. of Petroleum Engrs., Joint Meeting, Rocky Mountain Petroleum Sect's., Denver, Colo.

Aug. 21-27—XVI INTERNAT. CONG. OF ZOOLOGY, Washington, D. C. Dr. Gairdner B. Moment, Cong. Sec'y.-Gen., NAS-NRC, Washington 25, D. C.

Sept. 8-13—AMER. CHEM. SOC.: 144th Meeting, New York City.

Oct. 6-9—AIME: Soc. of Petroleum Engrs., Fall Meeting, New Orleans, La.

Oct. 20-24—SEGp: 33rd Ann. Internat. Meeting, Roosevelt and Jung Hotels, New Orleans, La.

Nov. 11-13—A.P.I.; Ann. Meeting, Chicago.

Nov. 13-16—GULF COAST ASSOC. of GEOL. SOC'S., Ann. Meeting, Hot Springs, Ark.

Nov.—GSA: Ann. Meeting, New York City.

Dec.—AAAS: Ann. Meeting, Milwaukee, Wis.

1964

Jan. 13-17—HIGHWAY RESEARCH BOARD, Ann., Meeting, Sheraton-Park Hotel, Washington, D. C.

Feb. 16-20—AIME: Ann. Meeting, New York City.

March 15-21—ACSM-ASP: Ann. Meeting, Shoreham Hotel, Washington, D. C.

March 31-April 9—AMER. CHEM. Soc.: 145th Meeting, Philadelphia, Pa.

April 13-15—CIM: 66th Ann. Gen. Meeting, Montreal, Que., Canada.

May 4-5—AIME: Soc. of Petroleum Engrs., Meeting, Wichita Falls, Tex.

May 18-21—AAPG-SEPM: 49th Ann. Meeting, jointly with Geol. Soc. of Canada, Royal York Hotel, Toronto, Ont., Canada.

Aug. 30-Sept. 4—AMER. CHEM. SOC.: 146th Meeting, Chicago, Ill.

Oct. 4-7—AIME: Soc. of Petroleum Engrs., Fall Meeting, Houston, Texas.

———GULF COAST ASSOC. OF GEOL. SOC'S., Ann. Meeting, Corpus Christi, Texas.

———SOUTHWESTERN FED. OF GEOL. SOC'S., Ann. Meeting, Midland, Texas.

LONG RANGE CALENDAR

This calendar has been prepared for several years by the AGI to aid in planning and scheduling of scientific meetings in geology and related sciences. Previously its distribution has been limited.

Henceforth, this calendar will be published twice a year in GeoTimes. We urge all concerned to provide concisely stated meeting notices for this calendar as soon as meeting dates become known.

Mrs. Kathryn Lohman
GeoTimes Calendar Editor
2101 Constitution Ave., N.W.
Washington 25, D.C.

Paleontological Association of Argentina

The Paleontological Association of Argentina was created in November 1955 to unite all persons with a common interest in paleontology. The periodical *Ameghiniana,* established for the dissemination of knowledge relative to Argentinian fossil studies, was named by the Association in honor of the great Argentine paleontologist, Florentino Ameghino. The first issue of the periodical appeared in 1957. The papers in the journal contain an English resumé.

Requests for information concerning the publications and the Association may be directed to *Librart, S.R.L., Casillo Correo 427, Buenos Aires, Argentina.*

1965

Jan. 11-15—HIGHWAY RESEARCH BOARD, Ann. Meeting, Sheraton-Park Hotel, Washington, D. C.

Feb. 14-18—AIME: Ann. Meeting, Chicago, Ill.

Mar. 29-April 3—ASP-ACSM: Ann. Meeting, Shoreham Hotel, Washington, D. C.

April 26-29—AAPG-SEPM: 50th Ann. Meeting, Municipal Auditorium, New Orleans, La.

May——AIME: Soc. of Petroleum Engrs., Meeting, Salt Lake City, Utah.

Sept. 12-17—AMER. CHEM. SOC., 148th Meeting, Atlantic City, N. J.

Oct. 3-6—AIME: Soc. of Petroleum Engrs., Fall Meeting, Dallas, Texas.

———GULF COAST ASSOC. OF GEOL. SOC'S., Ann. Meeting, Houston, Texas.

1966

Feb. 14-18—AIME: Ann. Meeting, New York City.

INTERNATIONAL MEETINGS

1962

May 8-?—7th INTERNAT. HYDROGRAPHIC CONF., Monte Carlo, Monaco. Write: Internat. Hydr. Bur., Quai des Etats-Unis, Monte Carlo.

July 24-27 INTERNAT. UNION OF CRYSTALLOGRAPHY, Celebration of the 50th Anniversary of the Discovery of X-Ray Diffraction, Munich. D. W. Smits, Gen. Sec'y., Internat. Union of Crystallography, c/o Laboratory of Inorganic and Physical Chemistry, 10 Bloemsingel, Groningen, Netherlands.

Aug. 27-31—INTERNAT. CONGRESS OF LIMNOLOGY, 15th, Madison, Wis., Dr. Arthur Halser, Chairman, c/o Dept. of Geology, Univ. of Wisconsin, Madison.

Nov. 13-21—INTERNAT. SOIL CONF., Palmerston North, New Zealand. Sec'y. Gen., P. O. Box 8001, Wellington, N.Z.

1963

June 19-26 — SIXTH WORLD PETROLEUM CONGRESS, Frankfurt, Germany. Dr. C. Weber, 1, Lange Reihe 14 I, Hamburg, Germany.

September — INTERNAT. UNION OF CRYSTALLOGRAPHY, 6th Gen. Assembly & Cong., Rome, Italy.

1964

——XII INTERNAT. GEOL. CONGRESS, India.

Norman D. Newell, Chairman and Curator of the Department of Fossil Invertebrates at the American Museum of Natural History and Professor of Geology at Columbia University, has been named recipient of the Mary Clark Thompson Medal of the National Academy of Sciences in recognition of his outstanding contributions in geology, particularly concerning the ecology of modern and ancient calcareous reefs.

The Mary Clark Thompson Medal of the National Academy of Sciences was established in 1919 by Mrs. Thompson to provide for the first time in the United States a substantial reward for distinguished services to geology or paleontology. Its last three recipients are Professor Roman Kozlowski (1958), Dr. Gustav Arthur Cooper (1957), and Dr. Alfred S. Romer (1964).

Water Depletion Claimed

The *Wall Street Journal* recently carried the following note in its *Tax Report* column:

"A water depletion deduction is sought in a lawsuit filed against Uncle Sam in Federal District Court at Lubbock, Texas. Farmer Marvin Shurbet seeks to have underground water he uses for irrigating his 480-acre farm ruled a natural resource subject to depletion, as in the case of oil or gas. He argues that a steadily receding water level under his farm has reduced his capital investment in it, and that he should be permitted to recover such a loss of value through an annual depletion allowance."

Esper S. Larsen, Jr., well-known mineralogist and petrologist, died in Washington, D. C. on March 8, 1961 at the age of 82. For 25 years Professor Larsen was a member of the Harvard University faculty in Geology and, upon retirement from academic life in 1949, he continued research work on the staff of the U. S. Geological Survey until 1958. He was recognized internationally for his work on the optical properties of minerals and contributed more than 100 published works to geology in the course of his career. He was a member of the National Academy of Sciences and was active in affairs of various scientific societies.

G. K. Gilbert Award

Geologist Clarence R. Allen reecntly received the first G. K. Gilbert Award which provides a sum of $9,000 to aid in the continuation of his study of fault scarps around the Pacific Basin. The award is made possible by the Harry Oscar Wood Fund administered by the Carnegie Institution of Washington. Dr. Allen, associate professor of geology at Cal Tech., is a fellow of the GSA and holds membership in the SSA and the AAPG.

Portland State College

The Oregon State Board of Higher Education recently authorized Portland State College to grant a degree in Earth Sciences. The staff of the Department of Earth Sciences is comprised of John Eliot Allen, Executive Officer, Robert O. Van Atta and Augustus K. Armstrong.

The AGI Visual Education Committee is in the process of bringing the AAPG 1951 *Directory of Films and Slides of possible interest to geologists* up-to-date. Many new films need to be reviewed. We of the committee are appealing to all geologists for help—let us know of new films and your opinions of films in existence—which are the best for teaching at college level, 9th grade level, for the tourist, etc. Also, and really most important for the future, what topics need to be covered by *first class* films (there are enough second class ones already!). Our first goal is to produce a pamphlet listing and describing the best available films for use by secondary school science teachers. This we plan to have ready for distribution to the various teacher institutes scheduled for the coming summer. Our next goal will be a complete, up-to-date catalogue of all films. Send your suggestions to the *Chairman of the AGI Visual Education Committee,* WILLIAM R. MUEHLBERGER, *Department of Geology, The University of Texas, Austin 12, Texas.*

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UNIVERSE. *16 mm. Sound. Black and white. 28 minutes. 1960.* An astronomer is shown operating the telescope and camera at an observatory near Toronto. His night vigil is a comprehensive journey through space and time, dealing in turn with the moon, planets, stars, comets, and galaxies. Facts are given about the dust storms over Venus, the asteroids beyond Mars, the lethal atmosphere of the giant Jupiter, the moons and ring encircling Saturn, the perpetual darkness of Pluto, the nebulae in the zodiacal constellation Taurus, and the newfound patterns of the Milky Way. Although models are used, the presentation is realistic, even awe-inspiring. "Universe" would enliven courses on the principles of geology at all levels. DISTRIBUTOR: *The National Film Board of Canada, 680 Fifth Avenue, New York 19, New York.* Available for rental fee of $7 from: *Contemporary Films Inc., 267 West 25th St., New York 1, New York or 614 Davis St., Evanston, Illinois; Wm. M. Dennis Film Libraries, 2506½ West 7th Street, Los Angeles 57, Calif.*

Reviewer: Oswald C. Farquhar

ENGINEERING GEOLOGY DATA

PHYSICAL PROPERTIES OF ROCKS

Compiled by Lawrence C. Wood, Stanford University

Table 1

ROCK TYPE	COHESION PSI T_o	TAN ϕ ϕ = Ang. of Int. Friction	PREDICTED DIP Assuming horiz. and vert. principal stresses in homogen. rock		AVERAGE COMPRESSIVE STRENGTH PSI	AVERAGE SPECIFIC GRAVITY	AVERAGE POROSITY PER CENT	ELASTIC CONSTANTS μ = Poisson's Ratio E = Young's Modulus G = Shear Modulus				
			NORMAL FAULTS	THRUST FAULTS				STATIC 10^6 PSI		DYNAMIC 10^6 PSI		
								μ	E	μ	E	G
ANDESITE	4060	1.0	67°	23°	19150	2.57	4.80	0.18	7.9			
	3970	1.0	67	23	18710		3.60	0.16	5.6			
BASALT	4500	1.1	69	21	24450	2.74	4.50	0.25	9.2			
	6340	1.2	70	20	31850	2.72	1.63	0.22	8.7			
DIORITE, QUARTZ	2010	1.4	72	18	12670	1.00	2.7	0.10	3.6	0.19	4.40	1.85
DIORITE GNEISS	1590	1.3	71	19	9310	1.00	1.07	0.06	3.1			
	2540	1.4	72	18	15140	2.86	0.10	0.11	4.2			
GRANITE, Med. Grnd.	3250	1.5	73	17	21580	2.63	1.59	0.13	4.8			
Slightly altered	1420	1.6	74	16	10460	2.63	1.0	0.12	3.9			
Slightly altered	1150	1.8	76	14	9400	2.61	2.36	0.20	1.0	0.10	2.2	1.0
PEGMATITE	1040	1.5	73	17	7000	2.61	1.0	0.09	2.8			
SUBGRAYWACKE, Coarse	1700	1.1	69	21	7900	2.46	10.3	0.05	1.7	0.06	3.8	1.8
Coarse Gnd.	910	1.2	70	20	4440	2.49	9.7	0.09	1.4	0.08	3.8	1.8
Fine Grained	1640	1.0	67	23	7010	2.41	12.0	0.07	1.7	0.23	3.7	1.5
Med. Grained	1650	1.0	67	23	7080	2.44	11.5	0.06	1.8	0.19	3.8	1.6
Med. Grained	1580	1.0	67	23	7350	2.49	9.7	0.06	1.4	0.29	3.6	1.4
LIMESTONE, Fine Grnd.	2150	1.6	74	16	11660	2.71	3.4	0.25	9.8	0.28	10.3	4.0
Med. Grnd.	5300	0.7	61	29	18480	2.68	4.7	0.19	4.9	0.31	7.6	2.9
Porous	2430	1.1	69	21	19320	2.44	13.9	0.20	2.8	0.20	4.1	1.7
Chalcedonic	2610	1.5	73	17	15580	2.60	5.4	0.20	3.8	0.25	6.8	2.7
Oolitic	2950	1.0	67	23	14420	2.67	1.6	0.18	6.8	0.21	7.8	3.2
Reef Breccia					4960	2.35	15.0	0.16	5.5			
Reef Breccia	180	0.6	60	30	860	2.25	32.7	0.12	1.1			
Reef Head					3080	1.79	36.0	0.24	3.0			
Stylotic	1920	1.7	75	15	11530	2.73	3.9	0.15	2.1	0.27	8.2	3.2
MONZONITE PORPHYRY	2390	1.7	75	15	18090	2.57	2.40	0.18	6.0	0.21	8.2	3.4
MONZONITE PORPHYRY	2860	2.1	77	13	25020			0.16	6.2			
MONZONITE PORPHYRY	3170	1.5	73	17	24730							
PHYLLITE, GRAPHITE	310	1.1	69	21	970	2.35	15.3		1.4		3.9	1.0
PHYLLITE, QUARTZ	250	1.2	70	20	1360	2.18	22.4	0.02	1.3		2.7	0.7
PHYLLITE, SERICITE	280	1.1	69	21	1420	2.34	17.4		2.5			
SANDSTONE	1690	1.1	69	21	8810	2.28	16.43	0.06	2.8	0.16	8.6	3.7
	2450				12200	2.37	11.21	0.17	3.9			
SCHIST, BIOTITE	2090	1.7	75	15	12010	2.70	1.44	0.18	5.8			
BIO-CHLOR.	780	2.3	78	12	12000	2.74	0.70	0.10	9.7			
BIO-SILL.	480	1.2	70	20	2300	2.72	2.0	0.02	3.5			
SERICITE	350	1.4	72	18	2180	2.47	11.4	0.12	1.2			
SHALE, CALCAREOUS	1160	2.1	77	13	5220	2.67	1.8	0.02	2.3		3.6	2.3
QUARTZOSE	3390	1.0	67	23	17770	2.69	6.6	0.07	2.3		3.2	1.7
SILTSTONE	720	1.2	70	20	3500	2.50	10.3	0.08	1.9		3.9	1.8
TUFF, LITHIC	100	0.9	66	24	530	1.45	42.48	0.08	0.18			

Table 2

ROCK TYPE	AVERAGE CRUSHING STRENGTH kg/cm^2	RANGE OF STRENGTH kg/cm^2	TENSILE STRENGTH kg/cm^2	SHEARING STRENGTH kg/cm^2
Granite	1480	370-3790	30-50	150-300
Syenite	1960	1000-3440		
Diorite	1960	960-2600		
Gabbro, Diabase, etc.	1800	460-4700		
Gneiss	1560	810-3270		
Quartzite	2020	260-3200	30-90	100-300
Marble	1020	310-2620	30-90	
Sandstone	740	110-2520	10-30	100-200
Limestone	960	60-3600	30-60	150-250
Slate	1480	600-3130	250	
Serpentine	1230	630-1230	60-110	180-340
Tuff	310	100- 520		
Basalt	2500	2000-3500		50-150
Felsite	2450	2000-2900		

Sources of Data

TABLE 1

Balmer, G. G., Physical properties of some typical foundation rocks: U. S. Bur. Reclamation lab. rept. SP-39, Denver, 1953

TABLE 2

Anderson, E. M., The dynamics of faulting: Oliver and Boyd, London, 1951

Billings, M. P., Structural geology, Prentice-Hall, New York, 1957

Birch, F., et al, Handbook of physical constants: Geol. Soc. Amer. Spec. Paper 36, 1942

DATA SHEET 24

This AGI Data Sheet, number 24 in the series, has been prepared by Lawrence C. Wood of Stanford University and edited by the AGI Data Sheet Committee which consists of the following members: *John E. Allen, William Beatty, Chester Longwell, George Thompson, Ian Campbell, Bob Wallace,* and *Richard M. Foose,* Chairman.

Suggestions for additional data sheets are welcomed by the Data Sheet Committee and should be forwarded to *Dr. Richard M. Foose, Earth Sciences Division, Stanford Research Institute, Menlo Park, California.*

THE USE OF MOHR'S CIRCLE IN GEOLOGY

Prepared by Lawrence C. Wood

In a two-dimensional stress system two perpendicular directions exist for which the shear stress (τ) is zero; these directions are called the principal directions, and the corresponding normal stresses (σ) are called the principal stresses. Defining the x and y axes as principal directions, the equations for the normal and shear stresses on an arbitrary plane can be shown to be,

STRESSES ON AN ARBITRARY PLANE (referred to principal axes)

$$\sigma = \sigma_x \cos^2\alpha + \sigma_y \sin^2\alpha = \tfrac{1}{2}(\sigma_x + \sigma_y) + \tfrac{1}{2}(\sigma_x - \sigma_y)\cos 2\alpha$$

$$\tau = (\sigma_y - \sigma_x)\sin\alpha\cos\alpha = \tfrac{1}{2}(\sigma_y - \sigma_x)\sin 2\alpha$$

The Mohr's circle is a nomograph which solves these equations; the locus of points which represent the stress components on any arbitrary plane making an angle α with the least principal stress axis is a circle, namely, the Mohr's circle. The stress components (σ and τ) vary with the angle α and are represented graphically by the Mohr's diagram in which σ and τ are taken as coordinates. Each arbitrary plane corresponds to a point on the (σ, τ) plane. The Mohr's circle is centered at $(\sigma_c, \tau_c) = \left(\frac{\sigma_x + \sigma_y}{2}, 0\right)$ and has a radius of magnitude $\left|\frac{\sigma_x - \sigma_y}{2}\right|$. Figures 1 and 2 are such diagrams. The following features of the Mohr's circle make it the most useful of all methods for analyzing stresses:

(1) Given the magnitudes and directions of the greatest and least principal stresses, the normal and shear stresses on any arbitrary plane can be determined; in other words, stresses are resolved by geometry rather than by algebraic manipulations.

(2) Given the normal and shear stress on any two perpendicular planes the direction of the principal stresses can be obtained by,

First: plotting these two points on the (σ, τ) plane
Second: constructing the Mohr's circle passing through these two points
Third: measuring the angle α which the principal stresses make with these planes.

The Mohr-Coulomb criterion of fracture states that when failure occurs, the normal and shear stresses on the plane of failure are connected by some functional relationship $\tau = f(\sigma)$. This curve is the envelope of all the circles containing points which correspond to the conditions of fracture. Specifically, the values of σ, τ, and α of the point of tangency of the Mohr's circle with the Mohr's envelope are the straight lines $\tau = \pm (\tau_0 + \sigma \tan\phi)$; τ_0 is called the cohesion, and ϕ is called the angle of internal friction of the material. Figure 2 is a typical example.

The Mohr's circle relates the angle of internal friction to the angle of dip. In general the three axes of stress are unequal; the plane of the fault will strike parallel to the intermediate stress axis, and it will be inclined to the least principal stress axis by the angle α. From figure 2 it is seen that $2\alpha = 90^\circ + \phi$ or $\alpha = 45^\circ + \phi/2$. Thus, when the principal stresses are horizontal and vertical, the dip of normal faults is $45^\circ + \phi/2$ and the dip of thrust faults is $45^\circ - \phi/2$. Strike slip faults dip 90° and the angles between conjugate sets of faults are $90^\circ \pm \phi$.

Experiment shows that the Mohr envelope for most rock materials is very close to a straight line of the form $\tau = \tau_0 + \sigma \tan\phi$. The shear strength τ_0 and the angle of internal friction ϕ of a rock are usually determined by triaxial tests. Since direct measurements of these quantities are not feasible, Mohr's circles are determined by measuring the lateral and axial stresses. The envelope of these circles gives the relationship between the normal and shearing stress. The results of a series of tests on some typical foundation rocks, conducted by the U. S. Bureau of Reclamation, in the manner just described, are summarized in Table 1. The elastic constants of the specimens have been determined by both static and dynamic tests. Dynamic tests subject the specimens to vibrations instead of static loads. The loads due to vibrations are very small and of extremely short duration; the duration is seldom longer than 1/8,000 of a second. The static constants are of significance in geology; the dynamic constants on the other hand, are of significance in seismic wave propagation.

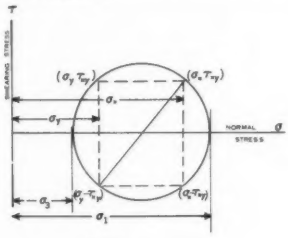


Figure 1
Mohr's Circle

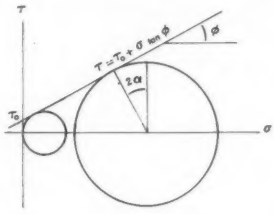
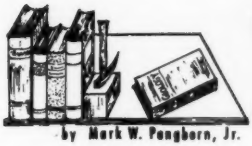


Figure 2
A Typical Mohr's Diagram

$$\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right) + \tau_{xy}^2} \qquad \tau_{max} = \frac{1}{2}(\sigma_1 - \sigma_3)$$

$$\sigma_3 = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right) + \tau_{xy}^2} \qquad \frac{\sigma_1 + \sigma_3}{2} = \frac{\sigma_x + \sigma_y}{2} \qquad \frac{\sigma_1 - \sigma_3}{2} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$



Popular Geology in print

by Mark W. Pengborn, Jr.

The rising interest in the sea is reflected in a growing output of popular books. Science-writer *Robert C. Cowen's* FRONTIERS OF THE SEA (Doubleday, 1960, $4.95) is a well-balanced and most readable account of the major problems of oceanography, with emphasis on how scientists are presently trying to solve them; fine for anyone age 13 up. A third of this volume is devoted to sea bottom geology, another third concerns waves and oceanic currents, and the final portion covers ocean life and applied marine biology. More maps and diagrams would help; there is a short annotated bibliography.

Journalist *Ruth Brindze*, in her ALL ABOUT UNDERSEA EXPLORATION (Random House, 1960, $1.95), also shows how oceanographers are probing the oceans secrets by means of coring devices, echo sounders, and bathyscaphs, and introduces the reader to late developments in submarine archaeology, underwater photography, and the search for oil beneath the sea. A rather disconnected kind of book, but youngsters 10 to 14 will doubtless lap it up; adequate pictures and a short unannotated bibliography.

Another fine popularization for ages 13 up is naturalist *Richard Carrington's* A BIOGRAPHY OF THE SEA (Basic Books, 1960, $5); unlike Cowan, the author passes rather lightly over physical oceanography in favor of straight description of marine life, and his chapter on oceanographers deals chiefly with classic figures like Maury. Illustrations are adequate, and include two choice restorations by Maurice Wilson; the considerable bibliography is, unfortunately, neither classed nor annotated.

In UNDER THE DEEP OCEANS (Norton, 1960, $3.95), *Thomas Frohock Gaskell*, chief scientist on the 1950-53 Challenger expedition, mingles observations made on this voyage with a meaty summary of our current understanding of sea-bottom geology. Despite the author's happy belief that "everyone possesses a smattering of geological knowledge" we think that this volume will appeal mainly to the more knowledgeable layman or high school student, largely because there are so few maps and diagrams to help in visualizing the unfamiliar subject matter; no bibliography.

SEVEN MILES DOWN (Putnam, 1961, $5), by scientists *Jacques Piccard* and *R. S. Dietz*, tells the fascinating history of the bathyscaph Trieste, from shallow dives off Dakar in 1948 to its purchase by the U. S. Navy and its subsequent 35,800 foot descent to the bottom of the Challenger Deep, off Guam, in 1960. Two concluding chapters suggest future research; adequate illustrations.

Stanley E. Jerome, has been named Associate Director of the Nevada Bureau of Mines and the Nevada Mining Analytical Laboratory, Reno. Dr. Jerome, an economic geologist, holds membership in SEG and AIME.

Lamont Starts Buildings

The Lamont Geological Observatory of Columbia University at Palisades, N. Y. has embarked on a building program which will add two new laboratory buildings for geophysical and oceanographic work with a total of 45,000 square feet of new space.

The present construction constitutes the largest building program since Mrs. Thomas W. Lamont, widow of the financier, presented the Torrey Cliff estate to Columbia after Mr. Lamont's death in 1948. The University turned the property over to its Department of Geology, and the palatial estate was transformed into a center of instruction and research in the earth sciences that has become world-famous. It opened in the fall of 1949 for the 1949-50 academic year.

GEOLOGISTS-ENGINEERS

(Continued from page 17)

entire group participating in their solution. From this single meeting, a preliminary cost estimate was compiled which was satisfactory to all concerned.

The point I emphasize is that in both these examples an entire problem was attacked by a group of specialists who participated together in all phases of the study before a report was submitted.

Interdisciplinary Stimulation

Where our groups function as teams, we note an increasing interest in geology displayed by engineers and likewise a growing interest in engineering among geologists. Some of our geologists are seeking civil engineering registration; some have taken extension courses in engineering economics, financing, law and other subjects related to public works development. From the standpoint of many of our civil engineers, the better a geologist understands the principles and practices of civil engineering and related subjects, the better qualified he is to apply geology to the solution of public works problems, assuming first, of course, that he is adequately trained in geology.

Team participation such as I have described is not yet practiced universally throughout the Department of Water Resources, and there are a few who still argue that the geologist's role should be limited to geology and the engineer's to engineering. Presumably, examples could be cited where that system would operate effectively. However, in our organization of 731 engineers, 22 economists, 13 chemists, 46 land and water use specialists, 15 recreation planners, and 85 geologists, the integrated approach has proven successful.

Lest there be any doubt about the ability of geologists to undertake important work outside the realm of their specialty, I refer to recent correspondence received from Robert C. Stephenson, Executive Director of the American Geological Institute in which he listed a number of geologists occupying managerial positions in major oil, mining and industrial companies. Twenty-three of these geologsts were either company presidents, vice presidents or board chairmen.

Now let us examine a rather obvious fundamental of engineering which geologists occasionally fail to appreciate. Basically, engineering is a quantitative science. The design of a dam, bridge, highway or tunnel is based on numerical values. These projects cannot be designed on the strength of generalities. Where conditions are such that it is impractical to measure or otherwise determine physical values, they must be estimated and appropriate factors for safety and contingency adopted. It is here that some training in civil engineering can help the geologist to appraise geology from the viewpoint of the requirements of the engineering designer.

Need New Techniques

There is a recognized need for the development of techniques with which more of these presently indeterminable factors can be reduced to reliable numerical values. This need poses a real challenge to your profession.

Many significant advances have been made in eliminating guess-work from public works planning, but there remains a long way to go. The foremost advance in reducing unknowns is perhaps the development of soil mechanics. This science was fathered by Dr. Karl Terzaghi, who is both geologist and engineer. Its proper application to foundation problems involves participation of both professions.

Significant advances in the field of cost estimation have been cited. Geologists with sound background in construction practices have demonstrated a remarkable aptitude for estimating quantities of explosives, drill steel and support that may be required in an excavation or the rate of heading advance to be expected in a tunnel.

Quantitative solutions to ground water problems have been the subject of intensive study by geologists and engineers for many years. Techniques have been developed for evaluating underflow and ground water basin storage capacities. These techniques are undergoing continued refinement as exemplified by the progressive improvement in pumping tests to determine transmissibility and storage coefficients. More recently the application of machine computing, both analog and digital, to the solution of ground water problems has provided a more comprehensive approach to many complex water supply problems. Although the fundamental mathematical equations involved in these problems have been known for years, their solutions heretofore have required labor too tedious and far too time consuming.

The advent of new specialists in the public works field by no means detracts from the importance of engineering geology. On the contrary, demands on the geologists are increasing. To the engineering geologist has fallen the task of evaluating the limitations of each newly developed instrument or technique as it relates to geologic problems. Geology must be

DEAR EDITOR:

May I voice a humble complaint regarding the perfunctory and uninformative quality of many of the book reviews in GEOTIMES? Your reviews are commendably brief, but they should be more than mere "accession annotations." Many of your geological readers are so situated that they cannot verify in a library whether the publication reviewed would be something they would like to own.

The leading review in your January-February number is of the new geologic map of Pennsylvania, but it does such scant justice to the map that it cannot have been written by anyone with a love of maps, or a knowledge of the geology of Pennsylvania. Actually, the map not only makes highly significant revisions of the geology of the State, but is an outstanding piece of cartography, with a unique color scheme that portrays vividly at a glance the geologic features of the State.

The review farther down on "The making of the broads" is equally evasive. It does contain a hint that the "interdisciplinary field" dealt with in the publication is one which has been a peripheral avocation of mine for many years, but I am left in a quandary as to whether the "refined techniques of dating" and other items in the publication will prove to be as "edifying" to me as the reviewer so fondly predicts.

Yours sincerely,

PHILIP B. KING

DEAR EDITOR:

I was delighted with your information concerning Geologists Fulton S. Gantt and Jules B. Sachs, (*"Behind an unmarked door"*, Jan.-Feb. '61 issue, p. 19).

It is wonderful to know that the distinguished geologists from New Orleans are so unabashedly sending the world's finest music from the most unappropriate place. Felicitations for such a magnificent undertaking.

ANIBAL R. MARTINEZ
Geologist—Creole Petroleum Corporation
President—Maracaibo Symphonic Society

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taken into consideration of the use of new techniques is to be properly programed and results correctly interpreted.

APPRECIATION OF ENGINEERING NEEDED

As a tip to the young engineering geologist, I will summarize frankly the views of some leading civil engineers in the Department of Water Resources. It has been observed that the successful engineering geologist associates freely with his civil engineer colleague; he develops a keen interest in public works projects and acquires a knowledge of engineering principles and practices in addition to a sound background in geology. He is willing to concede that engineering is important too. He also becomes aware of the economic and social impacts of proposed programs and projects and of the public relations and political problems involved. This is most important.

Speaking to your profession as a whole, I can recommend the integrated geologist-engineer relationship to which I have referred as the team approach. Teams need not be limited to geologists and engineers, but when appropriate may include seismologists, geophysicists, geochemists, nuclear physicists, economists and others as well.

Joint meetings and projects with engineering societies and the societies of other professions should be encouraged. Joint committees with the American Society of Civil Engineers to investigate public works problems involving both geology and engineering may achieve what neither organization can accomplish alone.

CONCLUSION

In conclusion, engineering-geology is a progressing and most challenging profession. Recognition has been slow in coming, but the public works team now looks to you for assistance in planning and constructing the many dams, highways, tunnels and bridges of the future. Methods for evaluating the parameters to be used in solving many of the technical problems that lie before are still largely undeveloped. Your willingness to join with your colleagues in related professions and jointly seek solutions to these many problems would appear to be one of the controlling factors in your future.

GEOLOGISTS' ASSOC.

(Continued from page 13)

Several of the Presidential addresses have been of wide appeal, both for the thoroughness of their content and for the excellence of their presentation. Among the more notable is the two-part *"Meditations on granite"*, by H. H. Read, now reprinted in the hard-cover book *"Granite controversy"*. The many other first-rate addresses have included such titles as *"Roofing materials through the ages"*, *"Study of fossil fishes"*, *"Clams as food for thought"*, *"Work for amateur geologists"*, and *"Genesis of sulphide ores"*, this last by the Centenary President, Professor David Williams.

In the early days of the association some of the presidents were clergymen and one was an ex-Lieutenant General. They were among the so-called amateurs, who alternated with the professionals. Those were the days when several Chairs of Geology were occupied by experts in other sciences, such as chemistry or medicine, and when the Heads of Departments paid their own assistants in a number of cases.

The G A has a fine book collection, partly dependent for its growth on exchanges, of which there are now more than 130. It is interesting to note here that the GSA, surely the world's largest publisher of geological literature, recently reduced its enormous exchange program. Latest available records show only 17 U.S. institutions as receiving the Proceedings of the G A, 15 of them by exchange and the others by subscription.

The G A has a number of small special funds to assist geological investigations and lecturing. One was established as a memorial to Henry Stopes, the first recipient being nominated by Marie Stopes, herself distinguished not only as a plant paleontologist but also as an early and ardent advocate of birth control.

Special activities include those of the Weald Research Committee that began soon after the first world war by setting itself the task of mapping the major parts of the three Wealden counties on a scale of six inches to the mile. Also, the Temporary Sections Committee has made invaluable records of excavations exposed for only short periods during construction projects, and particularly of the numerous bomb craters in the London area during the years of the second world war, 1939-1945. As there is no glacial drift around London, observation of such temporary sections has proved most important in bedrock mapping. There are several local groups in provincial towns, and these have regular gatherings, field meetings in the summer together with lectures and demonstrations in the winter. The only local group outside the United Kingdom is in Jamaica, a most active organization described in GeoTimes, April, 1957.

In view of the association's special position as a largely amateur group it may be worthwhile commenting on the status of the amateur in such a science as geology. The centenary volume has some pertinent observations to make. It has been pointed out that, outside his own particular groove, the specialist is on a par with others who seek to gain a general knowledge of geological work and progress. Any particular branch of science can certainly be advanced by the work of specialists, but does not really thrive without the encouragement of interested amateurs and even a few dilettantes. This is as true of space research and mathematics today as it was of alchemy and the earth sciences in days gone by.

It is no longer very easy to be an amateur at all. When less detail was known about every little thing and men's lives proceeded at a slower pace, one amateur could turn to another and say, "That, my dear fellow, is an echinoderm". Now, the story would be more involved and the ideal answer more difficult.

The enthusiasm of enlightened amateurs in the mid-nineteenth century seems to have known no bounds, and for a long time there was no branch of the natural sciences that attracted such universal attention as geology, at least in Great Britain. The centenary volume recalls the report of an 1849 field meeting held in the Wren's Nest district of the English Midlands and conducted by Sir Roderick Murchison. This great Silurian expert was hailed by a vast assembly as "King of Siluria", a description that he proudly acknowledged. And on that day no less than 25,000 persons visited the caverns there, now part of a nature reserve. No one but an actor or a politician could arouse a fraction of this kind of popular enthusiasm today.

The closing chapter of the centenary volume was written by one of the younger members of the association, and provides a glimpse into the future. Two paragraphs are of particular interest and so clearly express an important point of view that permission has been requested to quote them in full. They deserve careful reading, providing that the context in which they are written is appreciated. These remarks contain no element of defeatism when they are applied, as intended, to the present position of the Geologists' Association. The contributor quoted and individual members of the G A are as much aware of the general

Cripple Creek's Revenge

In 1914 the citizens of Cripple Creek, Colorado, were incensed by an article in Collier's Magazine in which a popular writer of the day, Julian Street, described Cripple Creek in most uncomplimentary terms. The article ignored the exciting history of Cripple Creek as one of the leading gold camps in the United States and stressed only the unsavory concentration of brothels and saloons along the town's infamous thoroughfare—Myers Avenue.

The citizens protested at length but Collier's and Mr. Street refused to apologize or retract. Finally, in a moment of clear, calm perception, the town council wiped out the insult by means of a simple official action. This action as reported by the Associated Press to an amused and delighted Nation read as follows:

The Town Council of Cripple Creek, Colorado, today unanimously approved a resolution changing the name of Myers Avenue to Julian Street.

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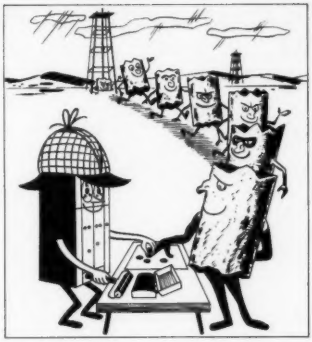
optimistic outlook for the mineral industries, 101 years after the G A was founded, as other thoughtful geoscientists. Following are the two paragraphs, quoted in full from page 143 of the previously cited volume.[2]

"Very much bound up with the future of the Geologists' Assocaition is, of course, the future of geology as a whole. Considerable changes must be expected in the applied aspects of our science. Thus it may well be that the need for fossil fuels such as coal and oil may dwindle away to nothing within a lifetime. Even the need for metalliferous minerals may dwindle with the further development of the plastics industry.[3] In the next century, it is perhaps possible that we may not need the minerals of the earth any more than we need horses for power and candles for light today. The geologist, as a technician, may become as outmoded as the blacksmith and the charcoal burner are today.

"Such changes would mean that geology would become a purely 'academic' science like archeology. This would not affect the function of the G A which has never greatly concerned itself with the economic aspects of geology, but it would certainly affect the nature and size of its membership. Our future would then largely depend on our ability to attract, once again, the popular interest which existed in the past".

[3] The possibility of striking coins of at least the lower values from colored plastic is seriously discussed in the last annual report of the Royal Mint in London, dated November 29, 1960.



GEOLOGISTS "FINGERPRINT" ROCK SAMPLES

The Hamarville Research Laboratories of the Gulf Oil Company have combined X-ray diffraction and computer techniques to speed the identification of minerals in well-cuttings and core samples by about 50 times over conventional manual techniques, thus freeing trained personnel from time-consuming monotonous sample examinations.

The samples are ground to fine powder and applied as a paste to slides which are fed by an automatic changer into the X-ray diffraction machine. The X-ray data are punched automatically into data cards. To aid in the identification an IBM 704 "memorizes" the characteristics of about 35 commonly observed minerals. The computer, through an elaborate mathematical program absorbs and digests the punch card data for a set of unknown samples, identifies the constitutent minerals, calculates their approximate percentage occurrence and correlates and prints out a complete analysis of the important minerals contained in the rock samples.

Mineral Leases on Federal Lands

The geological profession is not acutely aware of the responsibilities of the Conservation Division of the U. S. Geological Survey, charged with supervision of mining activities on Federal and Indian Lands. During the 10 year period ending in 1960, the number of mining leases tripled (to 1209 in 1960) and the production of minerals had increased 96 per cent to 13,674,550 short tons in 1960 when royalties on this production amounted to nearly $8 million. Potash, coal, sodium, uranium and phosphate rock were the most important minerals produced from federal lands.

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HISTORY OF THE EARTH

An Introduction to Historical Geology

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Avoiding provincial analyses except as documentation of his broad theme, Dr. Kummel presses toward the world view necessary for a comprehension of the earth's history in perspective. Drawing on all aspects of geology, as well as many other scientific disciplines involving physical, chemical, and biological data, he presents critically and logically a vast body of evidence on the progressive change and development of the earth's crust. This integrated treatment provides an important textbook and a stimulus for all students of the history of this planet.

1961, 624 pages, 517 illustrations, $8.75

PALEOGEOLOGIC MAPS

by A. I. Levorsen

This discussion of the preparation of paleogeologic maps considers some of the many interpretations that can be made from them. A varied collection of maps is presented—of oil fields, of regional areas, and of continental areas—and the reader is encouraged to work out the geology and the principles involved so as to develop a sense of analysis of geologic history. This book will be useful to students and practicing geologists, for it promotes a better understanding of the geologic episodes of large and small areas.

1960, 174 pages, 106 illustrations, $6.00

STRATIGRAPHY AND SEDIMENTATION

Second Edition

by W. C. Krumbein and L. L. Sloss

This complete revision of the first edition, published in 1951, reviews the fundamental aspects of the subject in view of the extensive advances of the past decade. New illustrations are presented throughout the book, and a sixteen-page section of two-color maps has been added. Stress is given to the importance of subsurface stratigraphic data and the resulting three-dimensional and regional views of stratigraphic problems. Analytical and interpretative aspects are emphasized rather than descriptive details. The second edition, like its predecessor, will be hailed as a clear and comprehensive text.

Ready December 1961

PHYSICAL GEOGRAPHY OF ASIATIC RUSSIA, by S. P. Suslov

Translated from the Russian by Noah D. Gershevsky and edited by Joseph E. Williams

Although Asiatic Russia comprises an area much larger than the United States, little is known about it. Now, with this English translation of the late S. P. Suslov's definitive study of the region, a full and detailed body of information is made available to a new audience. Because Professor Suslov's book delineates the total landscape, it will be of interest to geologists, geographers, and scientists in related fields. As a textbook for courses in the geography of Russia it is unequaled.

1961, 608 pages, 225 illustrations, $15.00

W. H. FREEMAN AND COMPANY, 660 MARKET STREET, SAN FRANCISCO 4, CALIF.

ANALOG *(Continued from page 11)*

assumptions used in designing the model of the aquifer system. The electric analog is not a magical instrument devised for learning the hydrology of an area from the place name, geographical coordinates, climatology, or population data. If we do not know the extent and nature of the aquifer system, the model design is indeterminate except for the alternative of arbitrarily declaring the aquifer to be "homogeneous and areally extensive for all practical purposes." From the practical aspect again, we cannot expect a model analysis to predict response to an impressed change in hydrology with great precision because our basic definition of the aquifer is always less than precise. However, the analysis of an aquifer flow system by electric analog permits the inclusion of more known variables than can be processed practically by other mathematical techniques or intuition, and also permits the analytical result to be expressed directly in familiar and useful numerical terms. However, it must always be recognized that the validity of the model analysis is directly tied to the completeness of the data and interpretations collected and furnished by the field hydrologist.

GROWING CONCERN

The Branch has established a computations section staffed with personnel selected for their experience in both hydrologic investigations and electronic instrumentation. The section, headed by B. J. Bermes, engineer, is in Phoenix, Arizona. It is physically set up to make electric-analog investigations in response to requests from the Ground Water Branch's field offices.

Since the computations section was declared operational early last year, demand for its services has increased rapidly. Worl currently in progress includes construction and study of areal ground-water flow models made in support of the continuing State cooperative investigations, and studies for other Federal agencies. Requests for most of the analog investigations are processed through the Branch's field offices, maintained in nearly all States.

Norden Congress Publications

Information on the availability and prices of the Proceedings and Guidebooks of the XXI International Geological Congress, Norden 1960 will be sent on request. Address requests for the list to the *American Geological Institute, 2101 Constitution Ave., N.W., Washington 25, D. C.*

Interdisciplinary Solid State Degree at Penn State

The Pennsylvania State University has established an interdisciplinary curriculum leading to the M.S. and Ph.D. degrees in Solid State Technology. Candidates for degrees will be accepted beginning with the 1961-62 school year. Degree candidates enrolled in the program may carry out their research and course work in the Colleges of Chemistry and Physics, Engineering and Architecture, Mineral Industries, or a combination of the three.

The solid state curriculum is grouped into four major areas: the structure of solids (crystal chemistry and structure determination); theory related to the solid state (physics, chemistry and mechanics); properties of solids (optical, electrical, magnetic, mechanical, thermal and chemical); and reactions of solids (phase equilibria, reaction mechanisms, reaction kinetics and surface reactions). One area must be encompassed in depth, with a substantial number of credits to be chosen from a combination of the other areas.

Landslide Charts Available from Highway Research Board

In 1958 the Highway Research Board published its Special Report 29, *Landslides and Engineering Practice* ($6.00). This book is still available. A limited number of copies of the very useful 18 by 24 inch *"Landslide Classification Chart"* which appeared as plate 1 in that volume are also available at a cost of $0.25 each from the *Highway Research Board, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington 25, D. C. Payment should accompany orders of $1.00 or less.*

MOUNT PRESS

Mount Press is the name given to a mountain in the Ellsworth Highland between Marie Byrd Land and Edith Ronne Land, about 700 miles from the South Pole in West Anarctica. The mountain is named in honor of Dr. Frank Press, Director of the Seismological Laboratory at California Institute of Technology in recognition "of the long and outstanding services rendered by him in the planning, organization and implementation of the United States Antarctic program during the International Geophysical Year.

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GLACIERS, *by Robert P. Sharp, 1960, 78 pp., University of Oregon Press, Eugene, Oregon, $1.25.*

A very excellent discussion of glaciers written in language that can be comprehended by the layman and student, aided by the included glossary, and appreciated by geological scientists. Beautifully illustrated. Based on lectures honoring Dr. Thomas Condon, the first professor of geology of the University. The cover photo of this issue of GeoTimes is taken from Plate 13b of this monograph.

PROCEEDINGS OF THE ELEVENTH ANNUAL SYMPOSIUM ON HIGHWAY ENGINEERING GEOLOGY, *1960, 119 pp., published by Florida Geological Survey, Tallahassee, Florida, $2.00.*

Contains 8 papers from the program of the February 1960 national conference on Highway engineering geology.

SOIL AND FOUNDATION ENGINEERING IN THE U.S.S.R., *1961, 188 pp. Highway Research Board Special Report 60, National Academy of Sciences Publication Office, 2101 Constitution Ave., N. W. $4.00.*

A report on the exchange visit of an American delegation in the Fall of 1959 with papers presented by Soviet soil scientists and engineers visiting the U.S. in the Spring of 1959.

ENERGY IN THE AMERICAN ECONOMY, 1850-1975, *by Sam H. Schurr and Bruce C. Netschert, 1960, 774 pp., The Johns Hopkins Press, Baltimore 18, Md., $12.50.*

A comprehensive historical review of energy development and consumption in the United States with a forecast of the period to 1975. The authors are staff members of Resources for the Future, Inc.

OPPORTUNITIES IN GEOLOGY AND GEOLOGICAL ENGINEERING, *by Alfred K. Snelgrove, 1960, 86 pp., Vocational Guidance Manuals, Inc. 212-22 48th Ave., Bayside 64, N.Y., $1.65.*

The booklet is one of the most comprehensive career guidance compilations on geology. Some may feel that there is disproportionate attention given to geology vs. geological engineering. A serious oversight

is the failure to cite AGI Report 11, Directory of Geoscience Departments in the Colleges and Universities of the United States and Canada. RCS

TEXAS FOSSILS: *an amateur collector's handbook, by W. H. Matthews III, 1960, 123 pp., Guidebook 2, Bureau of Economic Geology, University of Texas, Austin, Texas, $1.00.*

A beautifully prepared, and most complete introduction to fossils, their classification and where they may be collected. We predict this booklet will be used as a reference in beginning Palentology in places far beyond the boundaries of the Lone Star State.

RUSSIAN-ENGLISH DICTIONARY OF EARTH SCIENCES, *by Mark E. Burgunker, 94 pp., 1961, Telberg Book Co., 544 Sixth Ave., New York 11, N. Y. $9.80*

More specifically a glossary of 1,900 terms commonly encountered in Russian literature on tectonics, geomorphology, hydrology, paleogeography and geophysics including a considerable peppering of botanical, zoological and ecological terms.

FIELD TRIP CALENDAR

(Continued from page 4)

May ??—MIDWESTERN FRIENDS OF PLEISTOCENE, no data available except that trip is to be conducted. Write C. P. Gravener, Geol. Div., Research Council of Alberta, Edmonton.

June 8-10—BILLINGS GEOL. SOC., a float trip in inflatable rafts down Big Horn Canyon prior to flooding by Yellowstone River dam to study Cretaceous to Cambrian in Canyon. Write: L. T. Hart, Box 318, Billings, Mont.

Aug. 2-5—WYOMING GEOL. ASSOC., 16th Ann. Field Conf. Trip to portions of Green River Basin, Rawlins Uplift, Wind River Basin and W. flank of Powder River Basin to study post-Cody and pre-Eocene stratig. Write: WGA, P.O. Box 545, Casper, Wyo.

Aug. 25-26 — FRIENDS OF THE PLEISTOCENE, Rocky Mountain Section, 7th Ann. Field Conf., Bear Lake-American Falls, Ida. Write for inf. and reservations: J. Stewart Williams, Utah State U., Logan.

Sept. 7-8—ROCKY MOUNTAIN ASSOC. OF GEOLOGISTS, field conf. to study pre-Pennsylvanian section in Salida, Monarch, Ouray, Silverton and Durango areas. Technical session in Salida night of Sept. 6. Write: Conf. chairman D. W. Bergman, 315 Colorado Bldg., Denver, Colo. Guidebook.

Sept. 7-9—ALBERTA SOC. PETROL. GEOL., trip to Turner Valley, Savannah Creek and Kananaskis Lakes, southwest Calgary foothills and mountains to study mountain structures and Paleozoic and Mesozoic stratig. Write: H. G. Gammell, 528 9th Ave., W., Calgary, Alta. Guidebook.

Oct. 5-8—NEW MEXICO GEOL. SOC., trip to Sandia Mtns., Hagan Basin, Jemez Mtns. in SE San Juan Basin and Lucero Uplift to study geology of Albuquerque area. Write: Charles Reed, USGS, Box 4083, Albuquerque. Guidebook.

Oct. 7—UTAH GEOL. SOC., trip to Bingham mining district and adjacent Oquirrh Mtns. to study stratig. and struct. of district and mountains. Write: Douglas R. Cook, 1935 S. Main St., Salt Lake City. Guidebook.

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October—TRI-STATE GEOL. FIELD CONF., a trip will be conducted, but no details available. Write: Stanley Harris, Dept. Geol., Southern Illinois Univ., Carbondale, Ill.

October—ASSOC. OF MISSOURI GEOL., trip to St. Francois Mtns. of Ozark Uplift to study Precambrian and engineering geology. Write: W. C. Hayes, Mo. Geol. Surv., Box 250, Rolla, Mo. Guidebook.

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GEOLOGY TEACHER for one year contract to teach undergraduate courses in Mineralogy, Petrography, and Petrology. Write to Prof. James S. Yolton, Chairman, Geology Department, Upsala College, East Orange, New Jersey.

DEPARTMENT OF GEOLOGY, Colorado State University invites applications from Ph.D.'s desiring to teach undergraduate courses selected from the following: Paleontology, stratigraphy, structural, physical and historical geology. Rank and salary open. Send resume to Chairman, Dept. of Geology, Colorado State University, Fort Collins, Colo.

LONG BEACH STATE COLLEGE, Long Beach 4, California. Opening September, 1961 for Assistant Professor of Geology with major field of emphasis either geochemistry-petrology or structure-engineering geology. Will teach undergraduate courses selected from mineralogy, petrology, structure, economic, and engineering geology. Ph.D. required. Send complete academic and biographical data to Dept. of Geology.

THE UNIVERSITY OF LEEDS, Department of Inorganic and Structural Chemistry. Senior RESEARCH ASSISTANT wanted as soon as possible to join a team doing research in high pressure chemistry, with some applications to geochemistry. Appointment for one year, with possibility of extension. A preference will be given to applicants who have done research in the field of high pressure geochemistry. Applications should be sent direct to Dr. R. S. Bradley, Department of Inorganic and Structural Chemistry, The University, Leeds, 2. England.

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BOX 748. EXPLORATION GEOLOGIST, Ph.D. Degrees in mining engineering and geology. 10 years field work with Canadian Geological Survey and Quebec Department of Mines. Teaching experience in physics and geology. Publications, physics and geology. Professional engineer. Six years geologic exploration in Venezuela and Brazil. Desires foreign work.

BOX 768. GEOLOGIST-MINERALOGIST, Ph.D., 31, family. Three years experience in major oil company research laboratory in fields of X-ray and fluorescence analysis, clay mineralogy and geochemistry of sediments. Broad graduate background in geology. Desires position at college or university. Available immediately.

BOX 769. PETROLEUM GEOLOGIST-STRATIGRAPHER, 33, M.S., family, 8 years varied experience in teaching, exploration, research and consulting, Texas, Mid-Cont., Appalachians & Rockies. Desire a responsible position in exploration or basin studies. Have supervisory experience. Will consider any position. Resume sent upon request.

BOX 774. GROUND WATER GEOLOGIST-HYDROLOGIST, 40, family. 1 year post graduate work. Five years experience with USGS, five years consulting. Geohydrology and engineering background with experience throughout U. S. Interested in position of responsibility. Open to foreign work. Resume on request.

BOX 776. PALEONTOLOGIST-STRATIGRAPHER, 40, M.S., Ph.D. expected '61. Desires teaching position with opportunity for research. 14 yrs. college teaching experience in paleontology, stratigraphy, sedimentology, historical, physical and petroleum geology and related fields. Experience includes state survey work. Publications.

BOX 786. GEOLOGIST, nine years experience in the Four Corners, Panhandle and West Texas. Broad exploratory background includes sub-surface, administration and seismograph. Some field and well work. Desires more responsibility.

BOX 787. GEOLOGIST, Ph.D. Desires teaching and research position in University in SEDIMENTARY PETROLOGY, STRATIGRAPHY (Principles), and SEDIMENTATION. Can also teach Regional Stratigraphy, Regional Geology, Historical Geology, Invertebrate Paleontology, Hand-specimen Petrology, Structural Geology, Geomorphology or Pleistocene Geology. Special interests include sedimentary rock petrogenesis, sedimentary structures and paleo-currents. Previous teaching experience at elementary and senior level. Field experience in North America and Europe. Location preferred: Northeast US, North-central US, Northern Rocky Mountains, Pacific Northwest and Canada. Currently employed.

BOX 789. GEOLOGIST, Ph.D. (1952) desires teaching position; morphological and optical crystallography, mineralogy, petrology, petrography and/or structural, regional, and historical geology. Over ten years teaching experience, mainly in large institutions; small or medium-sized college preferred.

BOX 792. GEOLOGIST, 25, single, European education, fluent English, French, German, Dutch. 2½ yrs. Canadian experience government surveys, copper-and asbestos exploration. Excellent references, resume on request. Main interests: structural geology, petrology. Desires seasonal or permanent employment with Canadian company or survey. Opportunity for research toward Ph.D. thesis appreciated. Available for interview and appointment May 1961.

BOX 794. MINING GEOLOGIST-PETROLOGIST, M.S. in Mining Geology. Age 28. Married, family. Experienced in X-Ray, D.T.A., and petrographic techniques. 3 yrs. with major company. Desires teaching or research position with University in Western U. S. offering Ph.D. program in geology. Will consider any type financial aid.

BOX 795. ASSISTANT PROFESSOR, 34, Ph.D. 7 yrs. teaching experience, 2 yrs. major oil company, desires to relocate. Main fields are invertebrate paleontology. sedimentology, stratigraphy, and structural geology. Has also taught petrology, optical mineralogy, and field geology. Summers have been spent mapping for a state survey. Resume on request.

BOX 796. ASST. PROF. Ph.D. Isolated State University wishes to teach in college or university in more desirable locale. Active researcher, Member professional societies, Bilingual, 5 yrs. varied governmental and industrial experience, 4 years teaching experience. Resume on request.

BOX 799. GEOPHYSICIST, 15 years experience exploration geophysics in U. S., Venezuela, Brazil and Libya. Broad background seismic techniques, experimental and production field operations, interpretation and evaluation of results in terms of geological objectives. Presently senior staff geophysicist, excellent references. Desires responsible position domestic or foreign.

GEOPHYSICIST, M.S., mining engineer, Ph.D. level geology. Broad physics and maths. background. 26 years worldwide experience in petroleum exploration and geophysical research. Languages: German, French, Spanish, Dutch, English. Seeks employment in research or petroleum exploration. P. O. Box 521, Oklahoma City, Okla.

BOX 805. PALEONTOLOGIST, Ph.D., 33, active specialist in lower macro-invertebrates with broad knowledge of geology and biology, 12 years of college teaching experience, also museum and field experience. Seeks position in museum, geological survey or university. Resume on request.

BOX 809. GEOLOGIST, B.A., 10½ yrs. experience oil exploration Arabia Libya, recon and detail surface, subsurface, some photogeology, hydrology and administration, single. Desire position foreign or U.S.

ENGINEERING GEOLOGIST, B.A.—Geol., M.S. —Eng. Geol., Age 32, married, 8 yr. exp. in water, geophysics and soils; J. Edwin Garrison, 434 William Dr., Brownsburg, Indiana.

BOX 810. WELL-SITE GEOLOGIST, 24, M.Sc., bachelor, desires job in any oil exploration co. Ready to serve anywhere on the globe. Well trained in stanvac in sub-surface geology. Three yrs. experience with oil and natural gas commission in well-site techniques. Well acquainted with electric log interpretation, modern method of stratigraphic analysis, and sedimentation. Interested in sub-surface correlation and basin studies. Three years contract. Available immediately.

BOX 811. GEOLOGIST, 28, single, East Indian, Ph.D., '59, major mid-western university. Desire college or university teaching position. Present research in structural geology. Substantial publication. Fields of interest, structural geology, economic geology, petrology and petrography. Available in September, 1961.

BOX 813. COLLEGE TEACHER, degrees major univ's. Desire to teach general courses in geology or oceanogr.; special work in sedimentation, stratigr., micropaleontology and marine geology.

BOX 814. EXPLORATION GEOLOGIST, B.S., LIB, 40, experienced, successful, principally metallic ores, also non-metallics, petroleum. Organize and/or manage ore-, raw materials-, or capital gains—finding program including negotiation, geologic, geochemical, and geophysical field work, drilling, valuation. Offer self-starting, creative leadership in exchange for aggressive backing.

BOX 815. STRATIGRAPHER-PETROLEUM GEOLOGIST, Ph.D., age early 40s, married, family, 15 years experience economic and academic. Experienced throughout major petroleum provinces and actual familiarity with West Coast Tertiary, Gulf Coastal Plain, Rocky Mountains and Appalachians (limited). Strong geography minor. Interested in responsible teaching position, especially foreign employment.

BOX 816. GEOLOGIST, M.A., Ph.D., Spring, 1961, 41, married. Three years part time teaching in major university (general, historical and structural geology) and ten years broad and varied domestic and foreign experience in petroleum geology including stratigraphic and structural investigations of continental scope. Desires stimulating teaching position with opportunity for research or imaginative research position in industry.

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BOX 818. GEOLOGIST-PALEONTOLOGIST, Ph.D., age 43, family, currently in temporary one year vacancy in major eastern university. Varied experience both commercial and academic. Courses taught include Field Principles, Regional Stratigraphy, Invertebrate Paleontology, Micro-paleontology and Sedimentation at both graduate and undergraduate level. Seek responsible teaching position.

BOX 819. GEOLOGY ENROLLMENT HAS BECOME MICROSCOPIC. Therefore, Geology Professor seeks other employment. Biostratigrapher, Ph.D., 35, family. Four years petroleum exploration and 4 years teaching experience. Will consider other teaching or industry position. Excellent references. Available this summer.

BOX 820. GEOLOGIST—B.S., M.S. June '61. Married, veteran, 26. Thesis: Petrology of S.S. Road Aggregate. Knowledge of X-Ray diffraction procedures. Interested in Ig. and Meta. Petrology. Recipient of State Roads Fellowship. Good references.

BOX 821. GEOLOGIST/SEISMOLOGIST, eight years experience exploration geophysics in U.S., Mexico, Brazil, Bolivia, and Libya. Broad background seismic techniques, field operations, interpretation and administration. Desire responsible position domestic or foreign. Resume and references on request.

BOX 822. GEOLOGIST, 30, B.S., M.S. in geology with a minor in chemistry. Experience in petrology dealing with composition and petrofabric analysis. Two years experience in hard-rock geology. Will do domestic or foreign work. Resume of experience, academic qualifications and references on request.

BOX 823. MICROPALEONTOLOGIST-GEOLOGIST, 29, M.A., Ph.D., Sept. 1961, desires academic position in university or college with opportunity for research. Principal interests: paleontology, paleoecology, stratigraphy, submarine geology, petroleum geology. Two years experience with major oil co. Publications.

BOX 824. HIGHWAY ENGINEERING GEOLOGIST, B.S., graduate school, 35, married, no children, 13 years experience with Federal & State governments in geophysics, foundation exploration, materials surveys—presently employed as Material Engineer with supervisory duties over compaction testing, aggregate production, concrete and asphalt control. Would like foreign or domestic work. Consider teaching assignment. Resume on request.

BOX 825. DISPLACED MINERALOGIST-PETROGRAPHER, 31, M.S., desires immediate geological employment, foreign or domestic. Speak Spanish, single, will consider teaching.

BOX 826. INVERTEBRATE PALEONTOLOGIST, recent M.A. (Late Paleozoic) Univ. Calif., seeks summer job museum, field, research ass't, etc. Field experience. Free to travel. Available June 15 through Sept. 15.

BOX 827. GROUND WATER ENGINEER. 42, small family. Experience includes all phases ground water exploration and development in Saudi Arabia, Jordan, Spain, East Africa, Turkey and Iran. Experienced in dealing with foreign governments at all levels. Desires responsible supervisory position. Now employed, available about August. Resume on request.

BOX 828. PETROLEUM GEOLOGIST, MA, 10 years experience all phases oil and gas exploration with major companies and consulting in Rocky Mountain area and Williston Basin. Lease and farmout experience. Administrative ability, family, veteran. Desire responsible position with small aggressive group, will travel. Excellent references. Resume on request.

BOX 829. GEOCHEMIST, 29, family, Ph.D. expected '61. Ten yrs. geological field experience, seven supervising exploration geochemistry. Masters and doctorate thesis on low temperature reactions of sulphides. Considerable lecturing and demonstrating experience. Excellent references on teaching and field abilities. Desires teaching and/or research appointment commencing autumn; would consider industry position of semi-research nature.

BOX 830. PALEONTOLOGIST, 44, single, 15 years experience with Tertiary and Cretaceous foraminifera, and ammonites, in California, Colombia and Libya, seeks overseas position with oil company. Has also done some wellsite and field work. Good knowledge of Spanish; learning Arabic.

BOX 831. CRYSTALLOGRAPHER-MINERALOGIST, 30, Ph.D. in soil science, Ph.D. in geology expected, summer 1961. Experience in clay mineralogy, single crystal x-ray structure determination. Desires teaching and/or research position. Resume of qualifications, publications upon request.

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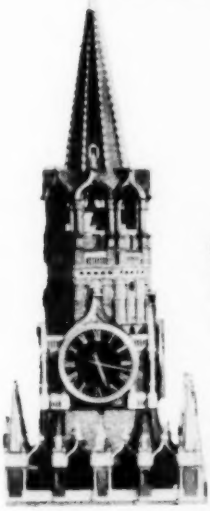

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N. Y. Times, Sunday January 22, 1961, Section 1, p. 61, "Australians kill amiable Wombat"

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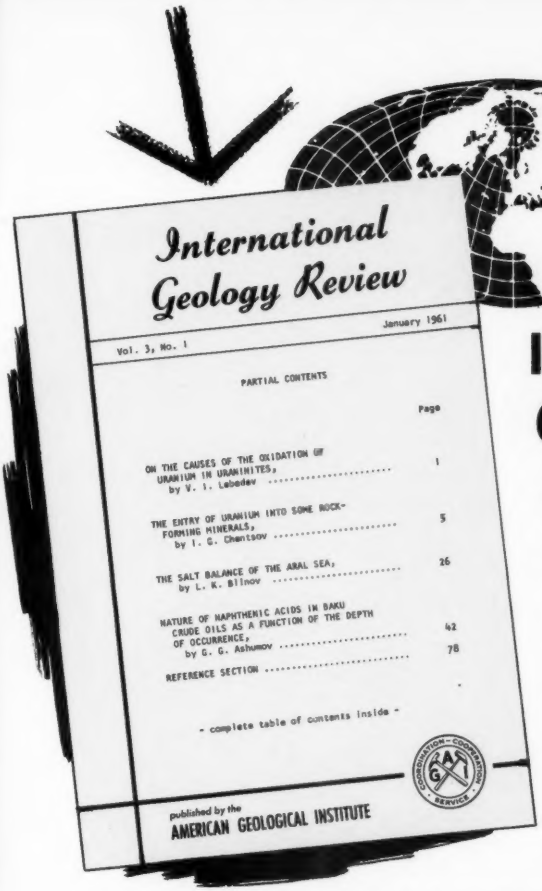
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